

Electricity and Magnetism, United Kingdom, NPL (National Physical Laboratory)

Calibration or Measurement Services			Measurand Level or Range			Measurement Conditions/Independent variables		Expanded Uncertainty							
Quantity	Instrument or artifact	Instrument Type or Method	Minimum value	Maximum value	units	Parameter	Specifications	Value	Units	Coverage Factor	Level of Confidence	Is the expanded uncertainty a relative one?	Uncertainty matrix	Comments	NMI Service Identifier
DC voltage sources: single values	Solid state voltage standard	Direct comparison with standard	1	1	V			0.14	µV/V	2	95%	Yes			1
DC voltage sources: single values	Solid state voltage standard	Direct comparison with standard	1.018	1.018	V			0.14	µV/V	2	95%	Yes			2.1
DC voltage sources: single values	Standard cell	Direct comparison with standard	1.018	1.018	V			0.08	µV/V	2	95%	Yes			2.2
DC voltage sources: single values	Solid state voltage standard	Direct comparison with standard	10	10	V			0.02	µV/V	2	95%	Yes			3
DC voltage sources: low values	Solid state voltage standard	Direct comparison with standard	1	10	V			0.02	µV/V	2	95%	Yes			4
DC resistance standards and sources: low values	Fixed resistor	DCC, CCC	100	100	µΩ	Maximum power dissipation	1 mW	2.4	µΩ/Ω	2	95%	Yes			7
DC resistance standards and sources: low values	Fixed resistor	DCC, CCC	1	1	mΩ	Maximum power dissipation	1 mW	0.85	µΩ/Ω	2	95%	Yes			8
DC resistance standards and sources: low values	Fixed resistor	DCC, CCC	10	10	mΩ	Maximum power dissipation	1 mW	0.8	µΩ/Ω	2	95%	Yes			9
DC resistance standards and sources: low values	Fixed resistor	DCC, CCC	100	100	mΩ	Maximum power dissipation	1 mW	0.18	µΩ/Ω	2	95%	Yes			10
DC resistance standards and sources: low values	Fixed resistor	CCC	1	1	Ω	Maximum power dissipation	1 mW	0.06	µΩ/Ω	2	95%	Yes			11
DC resistance standards and sources: intermediate values	Fixed resistor	CCC	10	10	Ω	Maximum power dissipation	1 mW	0.05	µΩ/Ω	2	95%	Yes			12

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DC resistance standards and sources: intermediate values	Fixed resistor	CCC	25	25	Ω	Maximum power dissipation	1 mW	0.05	μΩ/Ω	2	95%	Yes			13
DC resistance standards and sources: intermediate values	Fixed resistor	CCC	100	100	Ω	Maximum power dissipation	1 mW	0.02	μΩ/Ω	2	95%	Yes			14
DC resistance standards and sources: intermediate values	Fixed resistor	CCC	100	100	Ω	Maximum power dissipation	1 mW	0.05	μΩ/Ω	2	95%	Yes			15
DC resistance standards and sources: intermediate values	Fixed resistor	CCC	1	1	kΩ	Maximum power dissipation	1 mW	0.05	μΩ/Ω	2	95%	Yes			16
DC resistance standards and sources: intermediate values	Fixed resistor	CCC	10	10	kΩ	Maximum power dissipation	1 mW	0.06	μΩ/Ω	2	95%	Yes			17
DC resistance standards and sources: intermediate values	Fixed resistor	CCC	100	100	kΩ	Maximum power dissipation	1 mW	0.08	μΩ/Ω	2	95%	Yes			18
DC resistance standards and sources: intermediate values	Fixed resistor	CCC	1	1	MΩ	Maximum power dissipation	1 mW	0.12	μΩ/Ω	2	95%	Yes			19
DC resistance standards and sources: high values	Fixed resistor	CCC	10	10	MΩ	Maximum power dissipation	1 mW	0.2	μΩ/Ω	2	95%	Yes			20
DC resistance standards and sources: high values	Fixed resistor	CCC	100	100	MΩ	Maximum voltage	100 V	0.4	μΩ/Ω	2	95%	Yes			21

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DC resistance standards and sources: high values	Fixed resistor	CCC	1	1	GΩ	Maximum voltage	1000 V	1.6	μΩ/Ω	2	95%	Yes			22
DC resistance standard and sources: standards for high currents	Fixed resistor	DCC, CCC	0.0001	100	Ω	Voltage range	10 mV to 3 mV	5 to 0.5	μΩ/Ω	2	95%	Yes			28
						Maximum current	100 A								
DC resistance standards and sources: temperature coefficient	Fixed resistor	CCC	0.01	200	μΩ/Ω/K	Temperature	15 °C to 30 °C	0.002	μΩ/Ω/K	2	95%	No	The best uncertainty is achieved for resistors in the range from 1 Ω to 10 kΩ		31
DC resistance standards and sources: temperature coefficient	Fixed resistor	CCC	0.005	100	μΩ/Ω/K ²	Temperature	15 °C to 30 °C	0.001	μΩ/Ω/K ²	2	95%	No	The best uncertainty is achieved for resistors in the range from 1 Ω to 10 kΩ		32
AC resistance: real component	Fixed resistor	Coaxial ratio bridge	1	10000	Ω	Frequency range	40 Hz to 20 kHz	0.5 to 50	μΩ/Ω	2	95%	Yes	Matrix 1	This CMC is related to the next one	33
						Maximum power dissipation	1 mW								
AC resistance: time constant	Fixed resistor	Coaxial ratio bridge	1	500	ns	Resistance range	1 Ω to 10 kΩ	10	ns	2	95%	No	This CMC is related to the previous one		65
						Frequency range	40 Hz to 10 kHz								
AC resistance: resistors for high current	AC current shunt	Bridge and potentiometric techniques	0.0001	0.0001	Ω	Frequency	50 Hz	200 to 1000	μΩ/Ω	2	95%	Yes			66
						Current range	50 A to 1000 A								
AC resistance: resistors for high current	AC current shunt	Bridge and potentiometric techniques	0.001	0.001	Ω	Frequency range	50 Hz to 1000 Hz	100 to 500	μΩ/Ω	2	95%	Yes			67

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						Current range	10 A to 300 A								
AC resistance: resistors for high current	AC current shunt	Bridge and potentiometric techniques	0.01	0.01	Ω	Frequency range	10 Hz to 100 kHz	50 to 300	μΩ/Ω	2	95%	Yes			68
						Current range	5 A to 20 A								
AC resistance: resistors for high current	AC current shunt	Bridge and potentiometric techniques	0.1	0.1	Ω	Frequency range	10 Hz to 100 kHz	50 to 300	μΩ/Ω	2	95%	Yes			69
						Current range	1 A to 20 A								
AC resistance: resistors for high current	AC current shunt	Bridge and potentiometric techniques	1	1	Ω	Frequency range	10 Hz to 100 kHz	20 to 300	μΩ/Ω	2	95%	Yes			70
						Current range	0.5 A to 2 A								
Capacitance: low loss capacitors	Fused-silica standard capacitor	Coaxial bridge	10	10	pF	Frequency	1 kHz, 1.592 kHz	0.7	μF/F	2	95%	Yes		This CMC is related to the next one	71
Capacitance: dissipation factor for low loss capacitors	Fused-silica standard capacitor	Coaxial bridge	0	0.0001		Frequency	1 kHz, 1.592 kHz	0.000006		2	95%	No		This CMC is related to the previous one	88
						Capacitance	10 pF								
Capacitance: low loss capacitors	Fused-silica standard capacitor	Coaxial bridge	100	100	pF	Frequency	1 kHz, 1.592 kHz	0.9	μF/F	2	95%	Yes		This CMC is related to the next one	72
Capacitance: dissipation factor for low loss capacitors	Fused-silica standard capacitor	Coaxial bridge	0	0.0001		Frequency	1 kHz, 1.592 kHz	0.000007		2	95%	No		This CMC is related to the previous one	89
						Capacitance	100 pF								
Capacitance: low loss capacitors	Standard capacitor	Coaxial bridge	1	1000	pF	Frequency	1 kHz to 1MHz	3 to 2000	μF/F	2	95%	Yes	Matrix 5	Usually a two terminal standard This CMC is related to the next one	73
Capacitance: dissipation factor for low loss capacitors	Standard capacitor	Coaxial bridge	0	0.0001		Frequency	1 kHz to 1 MHz	0.000007 to 0.001		2	95%	No	Matrix 7a	This CMC is related to the previous one	90
						Capacitance	1 pF to 1 nF								

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Capacitance: dielectric capacitors	Standard capacitor	Coaxial bridge	1	1000	nF	Frequency	1 kHz to 1MHz	2 to 626	μF/F	2	95%	Yes	Matrix 5a	Usually a four terminal pair standard <i>This CMC is related to the next one</i>	75
Capacitance: dissipation factor for dielectric capacitors	Standard capacitor	Coaxial bridge	0	0.0001		Frequency	1 kHz to 1 MHz	2 to 935	1E-06	2	95%	No	Matrix 7b	Usually a four terminal pair standard <i>This CMC is related to the previous one</i>	92
						Capacitance	1 to 1000 nF								
Capacitance: transformed capacitors	Switched capacitor	Coaxial bridge	0.001	1000	mF	Frequency	100 Hz, 120 Hz, 1 kHz	1 to 10	mF/F	2	95%	Yes	Matrix 6	<i>This CMC is related to the next one</i>	80
Capacitance: dissipation factor for transformed capacitors	Switched capacitor	Coaxial bridge	0	0.01		Frequency	100 Hz, 120 Hz, 1000 Hz	0.001 to 0.01		2	95%	No	Matrix 7c	<i>This CMC is related to the previous one</i>	96
						Capacitance	1 μF to 1 F								
Inductance: self inductance, low values	Fixed inductor	Coaxial bridge	1	500	μH	Frequency	20 Hz to 10 kHz	75 to 20313	μH/H	2	95%	Yes	Matrix 8		102
Inductance: self inductance, intermediate values	Fixed inductor	Coaxial bridge	1	1000	mH	Frequency	20 Hz to 10 kHz	70 to 404	μH/H	2	95%	Yes	Matrix 8		112
Inductance: self inductance, high values	Fixed inductor	Coaxial bridge	2	10	H	Frequency	20 Hz to 10 kHz	69 to 803	μH/H	2	95%	Yes	Matrix 8		126
Mutual inductance	Fixed mutual inductor	Coaxial bridge	1	1	mH	Frequency	1 kHz	100	μH/H	2	95%	Yes			128
Mutual inductance	Fixed mutual inductor	Coaxial bridge	5	5	mH	Frequency	1 kHz	80	μH/H	2	95%	Yes			129
Mutual inductance	Fixed mutual inductor	Coaxial bridge	10	10	mH	Frequency	1 kHz	70	μH/H	2	95%	Yes			130
Mutual inductance	Fixed mutual inductor	Coaxial bridge	100	100	mH	Frequency	1 kHz	70	μH/H	2	95%	Yes			131

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AC voltage: AC-DC transfer difference at medium voltages	AC/DC transfer standard, thermal converter	Thermal converter "digital" bridge	1	5	V	Frequency	10 Hz to 1 MHz	5 to 51	µV/V	2	95%	Yes	Matrix 2		132
AC voltage: AC-DC transfer difference at low voltages	AC/DC transfer standard	Thermal converter "digital" bridge	0.001	0.5	V	Frequency range	10 Hz to 1 MHz	5 to 776	µV/V	2	95%	Yes	Matrix 2		141
AC voltage: AC-DC transfer difference at higher voltages	AC/DC transfer standard, thermal converter + range extender	Thermal converter "digital" bridge	10	1000	V	Frequency range	10 Hz to 1 MHz	6 to 62	µV/V	2	95%	Yes	Matrix 2		159
AC voltage up to 1000 V: meters	AC voltmeter, multimeter	Digital sampling	0.001	1000	V	Frequency	0.05 Hz to 201 Hz	20	µV/V	2	95%	Yes			183.1
AC voltage up to 1000 V: meters	AC voltmeter, multimeter	AD/DC transfer and DC voltage	0.5	1000	V	Frequency	10 Hz to 1 MHz	7 to 86	µV/V	2	95%	Yes	Matrix 3		183.2
AC voltage ratio: real component	Inductive voltage divider	Comparison with reference divider	0	1		Frequency	20 Hz to 203 Hz	2.0E-07 to 6.1E-08		2	95%	No	Matrix 9	This CMC is related to the next one	184
						Maximum RMS voltage	4 V to 30 V								
AC voltage ratio: imaginary component	Inductive voltage divider	Comparison with reference divider	-0.001	0.001		Frequency	20 Hz to 203 Hz	2E-07 to 7.6E-08		2	95%	No	Matrix 10	This CMC is related to the previous one	213
						Maximum RMS voltage	4 V to 30 V								
AC voltage ratio: real component	Inductive voltage divider	Comparison with reference divider	0	1		Frequency	40 Hz to 5 kHz	2.1E-07 to 6.1E-08		2	95%	No	Matrix 9	This CMC is related to the next one	190
						Maximum RMS voltage	4 V to 30 V								
AC voltage ratio: imaginary component	Inductive voltage divider	Comparison with reference divider	-0.001	0.001		Frequency	40 Hz to 5 kHz	7.6E-08 to 2.1E-07		2	95%	No	Matrix 10	This CMC is related to the previous one	219
						Maximum RMS voltage	4 V to 30 V								
AC voltage ratio: real component	Inductive voltage divider	Comparison with reference divider	0	1		Frequency	5 kHz to 120 kHz	2.1E-07 to 1.5E-05		2	95%	No	Matrix 9	This CMC is related to the next one	202
						Maximum RMS voltage	60 V								

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AC voltage ratio: imaginary component	Inductive voltage divider	Comparison with reference divider	-0.001	0.001		Frequency	5 kHz to 120 kHz	2.1E-07 to 1.6E-05		2	95%	No	Matrix 10	This CMC is related to the previous one	231
						Maximum RMS voltage	60 V								
AC voltage ratio: real component	Voltage transformer	IVD and mutual inductance bridge	1	1		Frequency	50 Hz	0.00005		2	95%	No		This CMC is related to the next one	212
						Maximum error	0.002								
AC voltage ratio: imaginary component	Voltage transformer	IVD and mutual inductance bridge	-2.4	2.4	mrad	Frequency	50 Hz	30	µrad	2	95%	No		This CMC is related to the previous one	241
AC current: AC-DC transfer difference	AC-DC standard + shunt	Thermal converter "digital" bridge	0.001	20	A	Frequency	10 Hz to 100 kHz	10 to 243	µA/A	2	95%	Yes	Matrix 4		242
AC current up to 100 A: meters	Current transducer	Comparison using 2 DVMs	5	100	A	Frequency	50 Hz	0.5	mA/A	2	95%	Yes			276.1
AC current ratio up to 100 A: real component	Compensated current transformer	Current comparator bridge	0.05	1		Frequency	50 Hz	10	1E-06	2	95%	Yes		This CMC is related to the next one	276.2
						Primary current	0.25 A to 5 A								
						Secondary current	5 A								
AC current ratio up to 100 A: imaginary component	Compensated current transformer	Current comparator bridge	0	1000	µrad	Frequency	50 Hz	10	µrad	2	95%	No		This CMC is related to the previous one	281
						Primary current	0.25 A to 5 A								
						Secondary current	5 A								
AC current ratio up to 100 A: real component	Compensated current transformer	Current comparator bridge	1	100		Frequency	50 Hz to 400 Hz	10	1E-06	2	95%	Yes		This CMC is related to the next one	277
						Primary current	5 A to 100 A								
						Secondary current	1 A and 5 A								

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AC current ratio up to 100 A: imaginary component	Compensated current transformer	Current comparator bridge	0	1000	µrad	Frequency	50 Hz to 400 Hz	10	µrad	2	95%	No		This CMC is related to the previous one	282
						Primary current	5 A to 100 A								
						Secondary current	1 A and 5 A								
AC current ratio up to 100 A: real component	Uncompensated current transformer	Current comparator bridge	0.05	1		Frequency	50 Hz	30	1E-06	2	95%	Yes		This CMC is related to the next one	278
						Primary current	0.25 A to 5 A								
						Secondary current	5 A								
AC current ratio up to 100 A: imaginary component	Uncompensated current transformer	Current comparator bridge	0	1000	µrad	Frequency	50 Hz	30	µrad	2	95%	No		This CMC is related to the previous one	283
						Primary current	0.25 A to 5 A								
						Secondary current	5 A								
AC current ratio up to 100 A: real component	Uncompensated current transformer	Current comparator bridge	1	100		Frequency	50 Hz to 400 Hz	30	1E-06	2	95%	Yes		This CMC is related to the next one	279
						Primary current	5 A to 100 A								
						Secondary current	1 A and 5 A								
AC current ratio up to 100 A: imaginary component	Uncompensated current transformer	Current comparator bridge	0	1000	µrad	Frequency	50 Hz to 400 Hz	30	µrad	2	95%	No		This CMC is related to the previous one	284
						Primary current	5 A to 100 A								
						Secondary current	1 A and 5 A								
AC current ratio up to 100 A: real component	Current transformer bridge	Resistance bridge	1	1		Frequency	50 Hz	3.0	1E-06	2	95%	Yes		This CMC is related to the next one	280
						Maximum error	20%								

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						Maximum current	5 A								
AC current ratio up to 100 A: imaginary component	Current transformer bridge	Resistance bridge	0.00001	0.01	rad	Frequency	50 Hz	3	μrad	2	95%	No		This CMC is related to the previous one	285
						Ratio	1								
						Maximum current	5 A								
AC power and energy: single phase ($f \leq 400$ Hz), active power	Wattmeter	Digital sampling	0	130	kW	Frequency	50 Hz to 400 Hz	41	μW/V·A	2	95%	Yes			286.1
						Voltage	1 V to 1000 V								
						Current	2 mA to 130 A								
						Power factor	1 to 0, inductive or capacitive								
AC power and energy: single phase ($f \leq 400$ Hz), reactive power	Wattmeter	Digital sampling	0	130	kvar	Frequency	50 Hz to 400 Hz	41	μvar/V·A	2	95%	Yes			286.2
						Voltage	1 V to 1000 V								
						Current	2 mA to 130 A								
						Power factor	1 to 0, inductive or capacitive								
AC power and energy: single phase ($f > 400$ Hz), active power	Wattmeter	3 voltmeter method	0.03	3000	W	Frequency	400 Hz to 30 kHz	200	μW/V·A	2	95%	Yes			286.3
						Voltage	0.3 V to 300 V								
						Current	0.1 A to 10 A								
						Power factor	1								
AC power and energy: single phase ($f > 400$ Hz), active power	Wattmeter	3 voltmeter method	0	3000	W	Frequency	400 Hz to 30 kHz	500	μW/V·A	2	95%	Yes			286.4
						Voltage	0.3 V to 300 V								
						Current	0.1 A to 10 A								

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						Power factor	1 to 0, inductive or capacitive								
AC power and energy: single phase ($f > 400$ Hz), active power	Wattmeter	3 voltmeter method	0	3000	W	Frequency	30 kHz to 100 kHz	1200	μW/V A	2	95%	Yes			286.5
						Voltage	0.3 V to 300 V								
						Current	0.1 A to 10 A								
						Power factor	1 to 0, inductive or capacitive								
High DC voltage: ratios	High voltage resistive divider	Comparison with reference divider	5E-06	1		Input voltage range	1 kV to 200 kV	13	1E-06	2	95%	Yes			290
High voltage impedance: capacitance	Compressed gas capacitor, capacitor for high voltage	Current comparator bridge	50	1000	pF	Input voltage range	1 kV to 80 kV	50	μF/F	2	95%	Yes	This CMC is related to the next one		291
						Frequency range	40 Hz to 60 Hz								
High voltage impedance: capacitance dissipation factor	Compressed gas capacitor, capacitor for high voltage	Current comparator bridge	0	1E-02		Input voltage range	1 kV to 80 kV	0.00004		2	95%	No	This CMC is related to the previous one		292
						Frequency range	40 Hz to 60 Hz								
High voltage impedance: resistance	Fixed resistors	Comparison with reference divider	1E+04	1E+09	Ω	Input voltage range	1 kV to 200 kV	40	μΩ/Ω	2	95%	Yes			293
AC high voltage: ratio error	High voltage transformers	Current comparator bridge	0	0.01		Input voltage	1 kV to 80 kV	42	1E-06	2	95%	No	Uncertainties quoted are for the best available transformers and will be increased for transformers with higher errors		295
						Frequency range	40 Hz to 60 Hz								
						Ratio	1 to 1000								

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AC high voltage: ratio: phase displacement	High voltage transformers	Current comparator bridge	5	1000	µrad	Input voltage	1 kV to 80 kV	30	µrad	2	95%	No		Uncertainties quoted are for the best available transformers and will be increased for transformers with higher errors	296.1
						Frequency range	40 Hz to 60 Hz								
						Ratio	1 to 1000								
AC high voltage: ratio: phase displacement	High voltage transformers, phase displacement d	Current comparator bridge	1000	100000	µrad	Input voltage range	1 kV to 80 kV	(30 + 0.01d)	µrad	2	95%	No		Uncertainties quoted are for the best available transformers and will be increased for transformers with higher errors	296.11
						Frequency range	40 Hz to 60 Hz								
						Ratio	1 to 1000								
High AC current: meters	Current transducer	Comparison using calibrated current transformer, resistor and 2 DVMs	0.1	10	kA	Frequency	50 Hz	0.5	mA/A	2	95%	Yes			296.2
High AC current: ratio error	Current transformer	Current comparator bridge	0	1E-04		Frequency range	50 Hz to 60 Hz	0.00001		2	95%	No			297
						Primary current range	above 100 A to 1 kA								
						Secondary current	1 A or 5 A								
High AC current: ratio error	Current transformer	Current comparator bridge	1E-04	1E-03		Frequency range	50 Hz to 60 Hz	0.00002		2	95%	No			298

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						Primary current range	above 100 A to 1 kA								
						Secondary current	1 A or 5 A								
High AC current: ratio error	Current transformer	Current comparator bridge	1E-03	1E-02		Frequency range	50 Hz to 60 Hz	0.0001		2	95%	No			299
						Primary current range	above 100 A to 1 kA								
						Secondary current	1 A or 5 A								
High AC current: ratio: phase displacement	Current transformer	Current comparator bridge	0	100	µrad	Frequency range	50 Hz to 60 Hz	10	µrad	2	95%	No			303
						Primary current range	above 100 A to 1 kA								
						Secondary current	1 A or 5 A								
High AC current: ratio: phase displacement	Current transformer	Current comparator bridge	100	1000	µrad	Frequency range	50 Hz to 60 Hz	20	µrad	2	95%	No			304
						Primary current range	above 100 A to 1 kA								
						Secondary current	1 A or 5 A								
High AC current: ratio: phase displacement	Current transformer	Current comparator bridge	1000	10000	µrad	Frequency range	50 Hz to 60 Hz	70	µrad	2	95%	No			305
						Primary current range	above 100 A to 1 kA								
						Secondary current	1 A or 5 A								
High AC current: ratio error	Current transformer	Current comparator bridge	0	1E-04		Frequency range	50 Hz	0.00001		2	95%	No			300
						Primary current range	above 1 kA to 10 kA								
						Secondary current	1 A or 5 A								
High AC current: ratio error	Current transformer	Current comparator bridge	1E-04	1E-03		Frequency range	50 Hz	0.00002		2	95%	No			301

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Calibration or Measurement Services			Measurand Level or Range			Measurement Conditions/Independent variables		Expanded Uncertainty							
Quantity	Instrument or artifact	Instrument Type or Method	Minimum value	Maximum value	units	Parameter	Specifications	Value	Units	Coverage Factor	Level of Confidence	Is the expanded uncertainty a relative one?	Uncertainty matrix	Comments	NMI Service Identifier
						Primary current range	above 1 kA to 10 kA								
						Secondary current	1 A or 5 A								
High AC current: ratio error	Current transformer	Current comparator bridge	1E-03	1E-02		Frequency range	50 Hz	0.0001		2	95%	No			302
						Primary current range	above 1 kA to 10 kA								
						Secondary current	1 A or 5 A								
High AC current: ratio: phase displacement	Current transformer	Current comparator bridge	0	100	µrad	Frequency range	50 Hz	10	µrad	2	95%	No			306
						Primary current range	above 1 kA to 10 kA								
						Secondary current	1 A or 5 A								
High AC current: ratio: phase displacement	Current transformer	Current comparator bridge	100	1000	µrad	Frequency range	50 Hz	20	µrad	2	95%	No			307
						Primary current range	above 1 kA to 10 kA								
						Secondary current	1 A or 5 A								
High AC current: ratio: phase displacement	Current transformer	Current comparator bridge	1000	10000	µrad	Frequency range	50 Hz	70	µrad	2	95%	No			308
						Primary current range	above 1 kA to 10 kA								
						Secondary current	1 A or 5 A								
Current and voltage waveform: current harmonics	Main frequency harmonics analysers, flicker meters. Current in A, dependent on wave shape	Digital sampling: IEC 1000-3-3, 1000-3-2	1	10	A	Harmonic number	up to 40	100	µA/A	2	95%	Yes			309
Electric fields below 50 kHz: electric field strength	Field strength probe	In TEM cell	0.5	500	V/m	Frequency range	10 Hz to 50 kHz	1	dB	2	95%	Yes			310

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Calibration or Measurement Services			Measurand Level or Range			Measurement Conditions/Independent variables		Expanded Uncertainty							
Quantity	Instrument or artifact	Instrument Type or Method	Minimum value	Maximum value	units	Parameter	Specifications	Value	Units	Coverage Factor	Level of Confidence	Is the expanded uncertainty a relative one?	Uncertainty matrix	Comments	NMI Service Identifier
Magnetic fields below 50 kHz: DC magnetic flux density	Field generator, magnetometer: flux density B	Fluxgate magnetometer	1E-09	2E-05	T			(5E-10 + 0.00015 B), B in T	T	2	95%	No			311
Magnetic fields below 50 kHz: DC magnetic flux density	Field generator, magnetometer	Proton resonance magnetometer	2E-05	9E-05	T			30	$\mu\text{T}/\text{T}$	2	95%	Yes			312
Magnetic fields below 50 kHz: DC magnetic flux density	Field generator, magnetometer	Hall effect magnetometer	9E-05	5E-02	T			2	mT/T	2	95%	Yes			313
Magnetic fields below 50 kHz: DC magnetic flux density	Field generator, magnetometer	NMR	5E-02	8	T			15	$\mu\text{T}/\text{T}$	2	95%	Yes			314
Magnetic fields below 50 kHz: DC magnetic flux density	Field generator	NMR	8	13.7	T			15	$\mu\text{T}/\text{T}$	2	95%	Yes			315
Magnetic fields below 50 kHz: AC magnetic flux density	Field generator, magnetometer	Search coil	1E-08	2.2E-02	T	Frequency	20 Hz to 60 Hz	2.5	mT/T	2	95%	Yes			316
Magnetic fields below 50 kHz: AC magnetic flux density	Field generator, magnetometer	Search coil	1E-08	1E-04	T	Frequency	60 Hz to 20 kHz	2.5	mT/T	2	95%	Yes			317
Magnetic fields below 50 kHz: AC magnetic flux density	Field generator, magnetometer	Search coil	1E-08	5E-06	T	Frequency	20 kHz to 50 kHz	7	mT/T	2	95%	Yes			318
Magnetic fields below 50 kHz: turn area	Pick up coil	Flux integrator	1E-04	2E+02	m^2	Frequency	DC	3	1E-03	2	95%	Yes			319
Magnetic fields below 50 kHz: turn area	Pick up coil	Mutual inductance bridge	2.9E-03	17	m^2	Frequency	12 Hz to 60 Hz	0.9	1E-03	2	95%	Yes			320
Magnetic fields below 50 kHz: turn area	Pick up coil	Induced voltage	1E-04	2E+02	m^2	Frequency	10 Hz to 12 Hz, 60 Hz to 20 kHz	2.5	1E-03	2	95%	Yes			321

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Calibration or Measurement Services			Measurand Level or Range			Measurement Conditions/Independent variables		Expanded Uncertainty							
Quantity	Instrument or artifact	Instrument Type or Method	Minimum value	Maximum value	units	Parameter	Specifications	Value	Units	Coverage Factor	Level of Confidence	Is the expanded uncertainty a relative one?	Uncertainty matrix	Comments	NMI Service Identifier
Magnetic fields below 50 kHz: turn area	Pick up coil	Induced voltage	1E-04	2E+02	m ²	Frequency	20 kHz to 50 kHz	7	1E-03	2	95%	Yes			322
Magnetic fields below 50 kHz: DC magnetic field strength	Field generator, magnetometer: field strength <i>H</i>	Fluxgate magnetometer	0.0008	16	A/m			(4E-04 + 0.00015 <i>H</i>), <i>H</i> in A/m	A/m	2	95%	No			323
Magnetic fields below 50 kHz: DC magnetic field strength	Field generator, magnetometer	Proton resonance magnetometer	16	72	A/m			30	1E-06	2	95%	Yes			324
Magnetic fields below 50 kHz: DC magnetic field strength	Field generator, magnetometer	Hall effect magnetometer	72	4E+04	A/m			2	1E-03	2	95%	Yes			325
Magnetic fields below 50 kHz: DC magnetic field strength	Magnetometer	NMR	4E+04	6.3E+06	A/m			15	1E-06	2	95%	Yes			326
Magnetic fields below 50 kHz: DC magnetic field strength	Field generator	NMR	6.3E+06	1.05E+07	A/m			15	1E-06	2	95%	Yes			327
Magnetic fields below 50 kHz: AC magnetic field strength	Field generator, magnetometer	Search coil	8E-03	1.75E+04	A/m	Frequency	20 Hz to 60 Hz	2.5	1E-03	2	95%	Yes			328
Magnetic fields below 50 kHz: AC magnetic field strength	Field generator, magnetometer	Search coil	8E-03	80	A/m	Frequency	60 Hz to 20 kHz	2.5	1E-03	2	95%	Yes			329
Magnetic fields below 50 kHz: AC magnetic field strength	Field generator, magnetometer	Search coil	8E-03	4	A/m	Frequency	20 kHz to 50 kHz	7	1E-03	2	95%	Yes			330
Magnetic fields below 50 kHz: AC magnetic field strength per unit current	Coil system	Resonance method	1	2E+04	1/m	Frequency	DC	0.15E-03		2	95%	Yes			331

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Calibration or Measurement Services			Measurand Level or Range			Measurement Conditions/Independent variables		Expanded Uncertainty							
Quantity	Instrument or artifact	Instrument Type or Method	Minimum value	Maximum value	units	Parameter	Specifications	Value	Units	Coverage Factor	Level of Confidence	Is the expanded uncertainty a relative one?	Uncertainty matrix	Comments	NMI Service Identifier
Magnetic fields below 50 kHz: AC magnetic field strength per unit current	Coil system	Mutual inductance bridge	5	2E+04	1/m	Frequency	12 Hz to 60 Hz	0.5E-03		2	95%	Yes			332
Magnetic fields below 50 kHz: AC magnetic field strength per unit current	Coil system	Induced voltage	1	100	1/m	Frequency	10 Hz to 12 Hz, 60 Hz to 20 kHz	2.5E-03		2	95%	Yes			333
Magnetic fields below 50 kHz: AC magnetic field strength per unit current	Coil system	Induced voltage	1	10	1/m	Frequency	20 kHz to 50 kHz	7E-03		2	95%	Yes			334
Electromagnetic fields above 50 kHz: electric field strength	Field probe	In TEM cell	0.5	500	V/m	Frequency range	50 kHz to 2.44 GHz	1	dB	2	95%	Yes			335
Electromagnetic fields above 50 kHz: electric field strength	Field probe	In anechoic chamber	0.2	300	V/m	Frequency range	2.45 GHz to 18 GHz	0.5	dB	2	95%	Yes			336
Electromagnetic fields above 50 kHz: electric field strength	Field probe	In anechoic chamber	0.2	200	V/m	Frequency range	18.1 GHz to 40 GHz	0.5	dB	2	95%	Yes			337
Electromagnetic fields above 50 kHz: electric field strength	Field probe	In anechoic chamber	15	100	V/m	Frequency range	43.5 GHz to 45.5 GHz	0.5	dB	2	95%	Yes			338
Electromagnetic fields above 50 kHz: magnetic field strength	Field generator, magnetometer	Search coil	8E-03	4	A/m	Frequency	50 kHz to 120 kHz	7E-03		2	95%	Yes			339
Electromagnetic fields above 50 kHz: power flux density	Field probe	In TEM cell	0.01	650	W/m ²	Frequency range	50 kHz to 2.44 GHz	1	dB	2	95%	Yes			340
Electromagnetic fields above 50 kHz: power flux density	Field probe	In anechoic chamber	0.01	200	W/m ²	Frequency range	2.45 GHz to 18 GHz	0.5	dB	2	95%	Yes			341

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Calibration or Measurement Services			Measurand Level or Range			Measurement Conditions/Independent variables		Expanded Uncertainty							
Quantity	Instrument or artifact	Instrument Type or Method	Minimum value	Maximum value	units	Parameter	Specifications	Value	Units	Coverage Factor	Level of Confidence	Is the expanded uncertainty a relative one?	Uncertainty matrix	Comments	NMI Service Identifier
Electromagnetic fields above 50 kHz: power flux density	Field probe	In anechoic chamber	0.01	100	W/m ²	Frequency range	18.1 GHz to 40 GHz	0.5	dB	2	95%	Yes			342
Electromagnetic fields above 50 kHz: power flux density	Field probe	In anechoic chamber	0.5	30	W/m ²	Frequency range	43.5 GHz to 45.5 GHz	0.5	dB	2	95%	Yes			343
Electromagnetic fields above 50 kHz: magnetic flux density	Field generator, magnetometer	Search coil	1E-08	5E-06	T	Frequency	50 kHz to 120 kHz	7	mT/T	2	95%	Yes			344
Electromagnetic fields above 50 kHz: magnetic field strength per unit current	Coil system	Induced voltage	1	10	m ⁻¹	Frequency	50 kHz to 120 kHz	7E-03		2	95%	Yes			345
Electromagnetic fields above 50 kHz: turn area	Pick up coil	Induced voltage	1E-04	2E+02	m ²	Frequency	50 kHz to 120 kHz	7E-03		2	95%	Yes			346
HF power: calibration factor on coaxials	Power sensors / calorimeters	DC substitution	1	10	mW	Frequency	100 kHz to 950 kHz	2	mW/W	2	95%	Yes			347
						Connector type	14 mm								
HF power: calibration factor on coaxials	Power sensors / calorimeters	DC substitution	1	10	mW	Frequency	1 GHz, 2 GHz, 3 GHz, 4 GHz, 5 GHz, 6 GHz, 7 GHz, 8 GHz	4	mW/W	2	95%	Yes			348
						Connector type	14 mm								
HF power: calibration factor on coaxials	Power sensors	DC or 50 MHz substitution	0.1	10	mW	Frequency	100 kHz to 100 MHz	2.5	mW/W	2	95%	Yes			349
						Connector type	7 mm (GPC 7 or Type N)								
HF power: calibration factor on coaxials	Power sensors	DC or 50 MHz substitution	0.1	10	mW	Frequency	100 MHz to 4 GHz	4	mW/W	2	95%	Yes			350
						Connector type	7 mm (GPC 7 or Type N)								

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Calibration or Measurement Services			Measurand Level or Range			Measurement Conditions/Independent variables		Expanded Uncertainty							
Quantity	Instrument or artifact	Instrument Type or Method	Minimum value	Maximum value	units	Parameter	Specifications	Value	Units	Coverage Factor	Level of Confidence	Is the expanded uncertainty a relative one?	Uncertainty matrix	Comments	NMI Service Identifier
HF power: calibration factor on coaxials	Power sensors	DC or 50 MHz substitution	0.1	10	mW	Frequency	4 GHz to 8 GHz	4.5	mW/W	2	95%	Yes			351
						Connector type	7 mm (GPC 7 or Type N)								
HF power: calibration factor on coaxials	Power sensors	DC or 50 MHz substitution	0.1	10	mW	Frequency	8 GHz to 12 GHz	5.5	mW/W	2	95%	Yes			352a
						Connector type	7 mm (GPC 7 or Type N)								
HF power: calibration factor on coaxials	Power sensors	DC or 50 MHz substitution	0.1	10	mW	Frequency	12 GHz to 15 GHz	6	mW/W	2	95%	Yes			352b
						Connector type	7 mm (GPC 7 or Type N)								
HF power: calibration factor on coaxials	Power sensors	DC or 50 MHz substitution	0.1	10	mW	Frequency	15 GHz to 18 GHz	7	mW/W	2	95%	Yes			352c
						Connector type	7 mm (GPC 7 or Type N)								
HF power: calibration factor on coaxials	Power sensors	DC or 50 MHz substitution	0.1	1	mW	Frequency	50 MHz to 100 MHz	10	mW/W	2	95%	Yes			353
						Connector type	3.5 mm								
HF power: calibration factor on coaxials	Power sensors	DC or 50 MHz substitution	0.1	1	mW	Frequency	100 MHz to 4 GHz	14	mW/W	2	95%	Yes			354
						Connector type	3.5 mm								
HF power: calibration factor on coaxials	Power sensors	DC or 50 MHz substitution	0.1	1	mW	Frequency	4 GHz to 8 GHz	18	mW/W	2	95%	Yes			355
						Connector type	3.5 mm								
HF power: calibration factor on coaxials	Power sensors	DC or 50 MHz substitution	0.1	1	mW	Frequency	8 GHz to 12 GHz	20	mW/W	2	95%	Yes			356
						Connector type	3.5 mm								
HF power: calibration factor on coaxials	Power sensors	DC or 50 MHz substitution	0.1	1	mW	Frequency	12 GHz to 16 GHz	24	mW/W	2	95%	Yes			357

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Calibration or Measurement Services			Measurand Level or Range			Measurement Conditions/Independent variables		Expanded Uncertainty							
Quantity	Instrument or artifact	Instrument Type or Method	Minimum value	Maximum value	units	Parameter	Specifications	Value	Units	Coverage Factor	Level of Confidence	Is the expanded uncertainty a relative one?	Uncertainty matrix	Comments	NMI Service Identifier
						Connector type	3.5 mm								
HF power: calibration factor on coaxials	Power sensors	DC or 50 MHz substitution	0.1	1	mW	Frequency	16 GHz to 20 GHz	26	mW/W	2	95%	Yes			358
						Connector type	3.5 mm								
HF power: calibration factor on coaxials	Power sensors	DC or 50 MHz substitution	0.1	1	mW	Frequency	20 GHz to 26.5 GHz	30	mW/W	2	95%	Yes			359
						Connector type	3.5 mm								
HF power: calibration factor on coaxials	Power sensors	DC or 50 MHz substitution	0.1	1	mW	Frequency	0.05 GHz to 8 GHz	20	mW/W	2	95%	Yes			360
						Connector type	2.4 mm								
HF power: calibration factor on coaxials	Power sensors	DC or 50 MHz substitution	0.1	1	mW	Frequency	8 GHz to 20 GHz	30	mW/W	2	95%	Yes			361
						Connector type	2.4 mm								
HF power: calibration factor on coaxials	Power sensors	DC or 50 MHz substitution	0.1	1	mW	Frequency	20 GHz to 30 GHz	40	mW/W	2	95%	Yes			362
						Connector type	2.4 mm								
HF power: calibration factor on coaxials	Power sensors	DC or 50 MHz substitution	0.1	1	mW	Frequency	30 GHz to 50 GHz	50	mW/W	2	95%	Yes			363
						Connector type	2.4 mm								
HF power: calibration factor on waveguides	Power sensors	Referenced to DC or 50 MHz	0.1	10	mW	Frequency	8.2 GHz, 8.5 GHz, 9.0 GHz, 10.0 GHz, 10.5 GHz, 11.0 GHz, 11.5 GHz, 12.0 GHz, 12.4 GHz	8	mW/W	2	95%	Yes			364
						Waveguide designation	R100								

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Calibration or Measurement Services			Measurand Level or Range			Measurement Conditions/Independent variables		Expanded Uncertainty							
Quantity	Instrument or artifact	Instrument Type or Method	Minimum value	Maximum value	units	Parameter	Specifications	Value	Units	Coverage Factor	Level of Confidence	Is the expanded uncertainty a relative one?	Uncertainty matrix	Comments	NMI Service Identifier
HF power: calibration factor on waveguides	Power sensors	Referenced to DC or 50 MHz	0.1	10	mW	Frequency	12.4 GHz, 12.5 GHz, 13.0 GHz, 13.5 GHz, 14.0 GHz, 14.5 GHz, 15.0 GHz, 15.5 GHz, 16.0 GHz, 16.5 GHz, 17.0 GHz, 17.5 GHz, 18.0 GHz	8	mW/W	2	95%	Yes			365
						Waveguide designation	R140								
HF power: calibration factor on waveguides	Power sensors	Referenced to DC or 50 MHz	0.1	10	mW	Frequency	18.0 GHz, 19.0 GHz, 20.0 GHz, 21.0 GHz, 22.0 GHz, 23.0 GHz, 24.0 GHz, 25.0 GHz, 26.0 GHz, 26.5 GHz	10	mW/W	2	95%	Yes			366
						Waveguide designation	R220								
HF power: calibration factor on waveguides	Power sensors	Referenced to DC or 50 MHz	0.1	10	mW	Frequency	27.0 GHz, 28.0 GHz, 29.0 GHz, 30.0 GHz, 31.0 GHz, 32.0 GHz, 33.0 GHz, 34.0 GHz, 35.0 GHz, 36.0 GHz, 37.0 GHz, 38.0 GHz, 39.0 GHz, 40.0 GHz	15	mW/W	2	95%	Yes			367
						Waveguide designation	R320								
HF power: calibration factor on waveguides	Power sensors	Referenced to DC or 50 MHz	0.1	10	mW	Frequency	40.0 GHz, 41.0 GHz, 42.0 GHz, 43.0 GHz, 44.0 GHz, 45.0 GHz, 46.0 GHz, 47.0 GHz, 48.0 GHz, 49.0 GHz, 50.0 GHz	18	mW/W	2	95%	Yes			368
						Waveguide designation	R400								

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Calibration or Measurement Services			Measurand Level or Range			Measurement Conditions/Independent variables		Expanded Uncertainty							
Quantity	Instrument or artifact	Instrument Type or Method	Minimum value	Maximum value	units	Parameter	Specifications	Value	Units	Coverage Factor	Level of Confidence	Is the expanded uncertainty a relative one?	Uncertainty matrix	Comments	NMI Service Identifier
HF power: calibration factor on waveguides	Power sensors	Referenced to DC or 50 MHz	0.1	10	mW	Frequency	50.0 GHz, 53.0 GHz, 55.0 GHz, 57.0 GHz, 60.0 GHz, 62.0 GHz, 64.0 GHz	20	mW/W	2	95%	Yes			369
						Waveguide designation	R620								
HF Power: calibration factor on waveguides	Power sensors	Referenced to DC or 50 MHz	0.1	10	mW	Frequency	75.0 GHz, 77.0 GHz, 80.0 GHz, 83.0 GHz, 85.0 GHz, 87.0 GHz, 90.0 GHz, 92.0 GHz, 94.0 GHz, 97.0 GHz, 100.0 GHz, 103.0 GHz, 105.0 GHz, 108.0 GHz, 110.0 GHz	26	mW/W	2	95%	Yes			370
						Waveguide designation	R900								
Scalar RF attenuation and gain: on coaxials	Passive device, amplifier: α	Voltage ratio	0.01	100	dB	Frequency range	10 kHz and 50 kHz, 0.5 MHz to 18 GHz	(6E-04 + 3E-05 α), α in dB	dB	2	95%	No	Alpha refers to magnitude of gain or attenuation, measurements are done at a fixed detection level, gain would be limited to 100 mW output power	371	
						Reflection coefficient	<= 0.005								
						Impedance	50 Ω								

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Calibration or Measurement Services			Measurand Level or Range			Measurement Conditions/Independent variables		Expanded Uncertainty							
Quantity	Instrument or artifact	Instrument Type or Method	Minimum value	Maximum value	units	Parameter	Specifications	Value	Units	Coverage Factor	Level of Confidence	Is the expanded uncertainty a relative one?	Uncertainty matrix	Comments	NMI Service Identifier
Scalar RF attenuation and gain: on coaxials	Passive device, amplifier: α	IF series substitution	> 100	120	dB	Frequency range	10 kHz and 50 kHz, 0.5 MHz to 18 GHz	0.01	dB	2	95%	No		Alpha refers to magnitude of gain or attenuation, measurements are done at a fixed detection level, gain would be limited to 100 mW output power	372
						Reflection coefficient	≤ 0.005								
						Impedance	50 Ω								
Scalar RF attenuation and gain: on coaxials	Passive device, amplifier: α	IF series substitution	> 120	140	dB	Frequency range	10 kHz and 50 kHz, 0.5 MHz to 18 GHz	0.02	dB	2	95%	No		Alpha refers to magnitude of gain or attenuation, measurements are done at a fixed detection level, gain would be limited to 100 mW output power	373
						Reflection coefficient	≤ 0.005								
						Impedance	50 Ω								

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Calibration or Measurement Services			Measurand Level or Range			Measurement Conditions/Independent variables		Expanded Uncertainty							
Quantity	Instrument or artifact	Instrument Type or Method	Minimum value	Maximum value	units	Parameter	Specifications	Value	Units	Coverage Factor	Level of Confidence	Is the expanded uncertainty a relative one?	Uncertainty matrix	Comments	NMI Service Identifier
Scalar RF attenuation and gain: on coaxials	Passive device, amplifier: α	Voltage ratio	0.01	80	dB	Frequency range	18 GHz to 40 GHz	2E-04 α , α in dB	dB	2	95%	No		Alpha refers to magnitude of gain or attenuation, measurements are done at a fixed detection level, gain would be limited to 100 mW output power	377
						Reflection coefficient	≤ 0.005								
						Impedance	50Ω								
Scalar RF attenuation and gain: on coaxials	Passive device, amplifier: α	Voltage ratio	0.01	90	dB	Frequency range	0.5 MHz to 1 GHz	(2E-03 + 6E-05 α), α in dB	dB	2	95%	No		Alpha refers to magnitude of gain or attenuation, measurements are done at a fixed detection level, gain would be limited to 100 mW output power	378
						Reflection coefficient	≤ 0.005								
						Impedance	75Ω								

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Calibration or Measurement Services			Measurand Level or Range			Measurement Conditions/Independent variables		Expanded Uncertainty							
Quantity	Instrument or artifact	Instrument Type or Method	Minimum value	Maximum value	units	Parameter	Specifications	Value	Units	Coverage Factor	Level of Confidence	Is the expanded uncertainty a relative one?	Uncertainty matrix	Comments	NMI Service Identifier
Scalar RF attenuation and gain: on coaxials	Passive device, amplifier: α	IF series substitution	> 90	110	dB	Frequency range	0.5 MHz to 1 GHz	0.01	dB	2	95%	No		Alpha refers to magnitude of gain or attenuation, measurements are done at a fixed detection level, gain would be limited to 100 mW output power	379
						Reflection coefficient	≤ 0.005								
						Impedance	75Ω								
Scalar RF attenuation and gain: on coaxials	Passive device, amplifier: α	IF series substitution	> 110	130	dB	Frequency range	0.5 MHz to 1 GHz	0.03	dB	2	95%	No		Alpha refers to magnitude of gain or attenuation, measurements are done at a fixed detection level, gain would be limited to 100 mW output power	380
						Reflection coefficient	≤ 0.010								
						Impedance	75Ω								

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Calibration or Measurement Services			Measurand Level or Range			Measurement Conditions/Independent variables		Expanded Uncertainty								
Quantity	Instrument or artifact	Instrument Type or Method	Minimum value	Maximum value	units	Parameter	Specifications	Value	Units	Coverage Factor	Level of Confidence	Is the expanded uncertainty a relative one?	Uncertainty matrix	Comments	NMI Service Identifier	
Scalar RF attenuation and gain: on waveguides	Passive device, amplifier: α	Voltage ratio	0.01	90	dB	Frequency range for TE10 mode	2.6 GHz to 3.95 GHz, 3.3 GHz to 4.9 GHz, 3.95 GHz to 5.85 GHz, 5.85 GHz to 8.2 GHz, 7.05 GHz to 10.0 GHz, 8.2 GHz to 12.4 GHz, 10.0 GHz to 15.0 GHz, 12.4 GHz to 18.0 GHz	(6E-04 + 6E-05 α), α in dB	dB	2	95%	No		Alpha refers to magnitude of gain or attenuation, measurements are done at a fixed detection level, gain would be limited to 100 mW output power	381	
						Reflection coefficient	<= 0.005									
						Waveguide designation	R32, R40, R48, R70, R84, R100, R120, R140									
Scalar RF attenuation and gain: on waveguides	Passive device, amplifier: α	Voltage ratio	0.01	80	dB	Frequency range for TE10 mode	18.0 GHz to 26.5 GHz, 26.5 GHz to 40.0 GHz, 33.0 GHz to 50.0 GHz	(1E-03 + 2E-04 α), α in dB	dB	2	95%	No		Alpha refers to magnitude of gain or attenuation, measurements are done at a fixed detection level, gain would be limited to 100 mW output power	389	
						Reflection coefficient	<= 0.005									
						Waveguide designation	R220, R320, R400									

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Calibration or Measurement Services			Measurand Level or Range			Measurement Conditions/Independent variables		Expanded Uncertainty								
Quantity	Instrument or artifact	Instrument Type or Method	Minimum value	Maximum value	units	Parameter	Specifications	Value	Units	Coverage Factor	Level of Confidence	Is the expanded uncertainty a relative one?	Uncertainty matrix	Comments	NMI Service Identifier	
Scalar RF attenuation and gain: on waveguides	Passive device, amplifier: α	Modulated subcarrier	0.01	60	dB	Frequency range for TE10 mode	50.0 GHz to 75.0 GHz	(2E-03 + 6E-04 α), α in dB	dB	2	95%	No		Alpha refers to magnitude of gain or attenuation, measurements are done at a fixed detection level, gain would be limited to 100 mW output power	392	
						Reflection coefficient	<= 0.005									
						Waveguide designation	R620									
Scalar RF attenuation and gain: on waveguides	Passive device, amplifier: α	Modulated subcarrier	0.01	60	dB	Frequency range for TE10 mode	75.0 GHz to 110 GHz	(2E-03 + 6E-04 α), α in dB	dB	2	95%	No		Alpha refers to magnitude of gain or attenuation, measurements are done at a fixed detection level, gain would be limited to 100 mW output power	393	
						Reflection coefficient	<= 0.01									
						Waveguide designation	R900									
Scattering parameters: reflection coefficient (S_{ii}) on coaxials, real and imaginary	Passive device, one port device	Network analyser	-1	1		Frequency range	30 kHz to 100 MHz	0.002		2.5	95%	No				394
						Connector types	PC-14, PC-7, type-N									
						Impedance	50 Ω									

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Calibration or Measurement Services			Measurand Level or Range			Measurement Conditions/Independent variables		Expanded Uncertainty							
Quantity	Instrument or artifact	Instrument Type or Method	Minimum value	Maximum value	units	Parameter	Specifications	Value	Units	Coverage Factor	Level of Confidence	Is the expanded uncertainty a relative one?	Uncertainty matrix	Comments	NMI Service Identifier
Scattering parameters: reflection coefficient (S_{ii}) on coaxials, real and imaginary	Passive device, one port device	Network analyser	-1	1		Frequency range	30 kHz to 100 MHz	0.004		2.5	95%	No			400
						Connector type	PC-3.5								
						Impedance	50 Ω								
Scattering parameters: reflection coefficient (S_{ii}) on coaxials, real and imaginary	Passive device, one and two port devices	Network analyser	-1	1		Frequency range	45 MHz to 8.5 GHz	0.001		2.5	95%	No			402
						Connector type	PC-14								
						Impedance	50 Ω								
Scattering parameters: reflection coefficient (S_{ii}) on coaxials, real and imaginary	Passive device, one and two port devices	Network analyser	-1	1		Frequency range	45 MHz to 18 GHz	0.002		2.5	95%	No			404
						Connector type	PC-7								
						Impedance	50 Ω								
Scattering parameters: reflection coefficient (S_{ii}) on coaxials, real and imaginary	Passive device, one and two port devices	Network analyser	-1	1		Frequency range	45 MHz to 18 GHz	0.003		2.5	95%	No			406
						Connector type	type-N								
						Impedance	50 Ω								
Scattering parameters: reflection coefficient (S_{ii}) on coaxials, real and imaginary	Passive device, one and two port devices	Network analyser	-1	1		Frequency range	45 MHz to 33 GHz	0.004		2.5	95%	No			408

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Calibration or Measurement Services			Measurand Level or Range			Measurement Conditions/Independent variables		Expanded Uncertainty							
Quantity	Instrument or artifact	Instrument Type or Method	Minimum value	Maximum value	units	Parameter	Specifications	Value	Units	Coverage Factor	Level of Confidence	Is the expanded uncertainty a relative one?	Uncertainty matrix	Comments	NMI Service Identifier
						Connector type	PC-3.5								
						Impedance	50 Ω								
Scattering parameters: reflection coefficient (Sii) on coaxials, real and imaginary	Passive device, one and two port devices	Network analyser	-1	1		Frequency range	45 MHz to 40 GHz	0.005		2.5	95%	No			410
						Connector type	K-connector								
						Impedance	50 Ω								
Scattering parameters: reflection coefficient (Sii) on coaxials, real and imaginary	Passive device, one and two port devices	Network analyser	-1	1		Frequency range	45 MHz to 50 GHz	0.005		2.5	95%	No			412
						Connector type	PC-2.4								
						Impedance	50 Ω								
Scattering parameters: reflection coefficient (Sii) on waveguides, real and imaginary	Passive device, one and two port devices	Network analyser	-1	1		Frequency range	8.2 GHz to 12.4 GHz	0.001		2.5	95%	No			414
						Waveguide designation	R100								
Scattering parameters: reflection coefficient (Sii) on waveguides, real and imaginary	Passive device, one and two port devices	Network analyser	-1	1		Frequency range	12.4 GHz to 18 GHz	0.002		2.5	95%	No			416
						Waveguide designation	R140								

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Calibration or Measurement Services			Measurand Level or Range			Measurement Conditions/Independent variables		Expanded Uncertainty							
Quantity	Instrument or artifact	Instrument Type or Method	Minimum value	Maximum value	units	Parameter	Specifications	Value	Units	Coverage Factor	Level of Confidence	Is the expanded uncertainty a relative one?	Uncertainty matrix	Comments	NMI Service Identifier
Scattering parameters: reflection coefficient (S_{ii}) on waveguides, real and imaginary	Passive device, one and two port devices	Network analyser	-1	1		Frequency range	18 GHz to 26.5 GHz	0.002		2.5	95%	No			418
						Waveguide designation	R220								
Scattering parameters: reflection coefficient (S_{ii}) on waveguides, real and imaginary	Passive device, one and two port devices	Network analyser	-1	1		Frequency range	26.5 GHz to 40 GHz	0.003		2.5	95%	No			420
						Waveguide designation	R320								
Scattering parameters: reflection coefficient (S_{ii}) on waveguides, real and imaginary	Passive device, one and two port devices	Network analyser	-1	1		Frequency range	33 GHz to 50 GHz	0.005		2.5	95%	No			422
						Waveguide designation	R400								
Scattering parameters: reflection coefficient (S_{ii}) on waveguides, real and imaginary	Passive device, one and two port devices	Network analyser	-1	1		Frequency range	50 GHz to 75 GHz	0.007		2.5	95%	No			424
						Waveguide designation	R620								
Scattering parameters: reflection coefficient (S_{ii}) on waveguides, real and imaginary	Passive device, one and two port devices	Network analyser	-1	1		Frequency range	75 GHz to 110 GHz	0.01		2.5	95%	No			426

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Calibration or Measurement Services			Measurand Level or Range			Measurement Conditions/Independent variables		Expanded Uncertainty							
Quantity	Instrument or artifact	Instrument Type or Method	Minimum value	Maximum value	units	Parameter	Specifications	Value	Units	Coverage Factor	Level of Confidence	Is the expanded uncertainty a relative one?	Uncertainty matrix	Comments	NMI Service Identifier
						Waveguide designation	R900								
Scattering parameters: transmission coefficient (S_{ij}) on coaxials, real and imaginary	Passive device, two port device: transmission T	Network analyser	-1	1		Frequency range	45 MHz to 8.5 GHz	0.0001		2.5	95%	No			477
						Connector type	PC-14								
						Impedance	50 Ω								
Scattering parameters: transmission coefficient (S_{ij}) on coaxials, real and imaginary	Passive device, two port device, transmission T	Network analyser	-1	1		Frequency range	45 MHz to 18 GHz	0.0002		2.5	95%	No			479
						Connector type	PC-7								
						Impedance	50 Ω								
Scattering parameters: transmission coefficient (S_{ij}) on coaxials, real and imaginary	Passive device, two port device, transmission T	Network analyser	-1	1		Frequency range	45 MHz to 18 GHz	0.0003		2.5	95%	No			481
						Connector type	type-N								
						Impedance	50 Ω								
Scattering parameters: transmission coefficient (S_{ij}) on coaxials, real and imaginary	Passive device, two port device, transmission T	Network analyser	-1	1		Frequency range	45 MHz to 33 GHz	0.0005		2.5	95%	No			483
						Connector type	PC-3.5								
						Impedance	50 Ω								

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Calibration or Measurement Services			Measurand Level or Range			Measurement Conditions/Independent variables		Expanded Uncertainty							
Quantity	Instrument or artifact	Instrument Type or Method	Minimum value	Maximum value	units	Parameter	Specifications	Value	Units	Coverage Factor	Level of Confidence	Is the expanded uncertainty a relative one?	Uncertainty matrix	Comments	NMI Service Identifier
Scattering parameters: transmission coefficient (S_{ij}) on coaxials, real and imaginary	Passive device, two port device, transmission T	Network analyser	-1	1		Frequency range	45 MHz to 40 GHz	0.0006		2.5	95%	No			485
						Connector type	K-connector								
						Impedance	50 Ω								
Scattering parameters: transmission coefficient (S_{ij}) on coaxials, real and imaginary	Passive device, two port device, transmission T	Network analyser	-1	1		Frequency range	45 MHz to 50 GHz	0.0006		2.5	95%	No			487
						Connector type	PC-2.4								
						Impedance	50 Ω								
Scattering parameters: transmission coefficient (S_{ij}) on waveguides real and imaginary	Passive device, two port device, transmission T	Network analyser	-1	1		Frequency range	8.2 GHz to 12.4 GHz	0.0004		2.5	95%	No			489
						Waveguide designation	R100								
Scattering parameters: transmission coefficient (S_{ij}) on waveguides real and imaginary	Passive device, two port device, transmission T	Network analyser	-1	1		Frequency range	12.4 GHz to 18 GHz	0.0005		2.5	95%	No			491
						Waveguide designation	R140								
Scattering parameters: transmission coefficient (S_{ij}) on waveguides real and imaginary	Passive device, two port device, transmission T	Network analyser	-1	1		Frequency range	18 GHz to 26.5 GHz	0.0006		2.5	95%	No			493

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Calibration or Measurement Services			Measurand Level or Range			Measurement Conditions/Independent variables		Expanded Uncertainty							
Quantity	Instrument or artifact	Instrument Type or Method	Minimum value	Maximum value	units	Parameter	Specifications	Value	Units	Coverage Factor	Level of Confidence	Is the expanded uncertainty a relative one?	Uncertainty matrix	Comments	NMI Service Identifier
						Waveguide designation	R220								
Scattering parameters: transmission coefficient (S_{ij}) on waveguides real and imaginary	Passive device, two port device, transmission T	Network analyser	-1	1		Frequency range	26.5 GHz to 40 GHz	0.0007		2.5	95%	No			495
						Waveguide designation	R320								
Scattering parameters: transmission coefficient (S_{ij}) on waveguides real and imaginary	Passive device, two port device, transmission T	Network analyser	-1	1		Frequency range	33 GHz to 50 GHz	0.0008		2.5	95%	No			497
						Waveguide designation	R400								
Scattering parameters: transmission coefficient (S_{ij}) on waveguides real and imaginary	Passive device, two port device, transmission T	Network analyser	-1	1		Frequency range	50 GHz to 75 GHz	0.0009		2.5	95%	No			499
						Waveguide designation	R620								
Scattering parameters: transmission coefficient (S_{ij}) on waveguides real and imaginary	Passive device, two port device, transmission T	Network analyser	-1	1		Frequency range	75 GHz to 110 GHz	0.001		2.5	95%	No			501
						Waveguide designation	R900								
RF noise: noise temperature in coaxials	Noise source	Radiometer	77	100000	K	Frequency	10 MHz to 18 GHz	10	mK/K	2	95%	Yes			428
						Connector type	GPC-7								

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Calibration or Measurement Services			Measurand Level or Range			Measurement Conditions/Independent variables		Expanded Uncertainty							
Quantity	Instrument or artifact	Instrument Type or Method	Minimum value	Maximum value	units	Parameter	Specifications	Value	Units	Coverage Factor	Level of Confidence	Is the expanded uncertainty a relative one?	Uncertainty matrix	Comments	NMI Service Identifier
RF noise: noise temperature in coaxials	Noise source	Radiometer	77	100000	K	Frequency	18 GHz to 26.5 GHz	20	mK/K	2	95%	Yes			429
						Connector type	2.4 mm								
RF noise: noise temperature in coaxials	Noise source	Radiometer	77	100000	K	Frequency	26.5 GHz to 40 GHz	23	mK/K	2	95%	Yes			430
						Connector type	2.4 mm								
RF noise: noise temperature in waveguides	Noise source	Radiometer	600	1000000	K	Frequency	2.6 GHz to 4 GHz	10	mK/K	2	95%	Yes			431
						Waveguide designation	R32								
RF noise: noise temperature in waveguides	Noise source	Radiometer	600	1000000	K	Frequency	5.4 GHz to 8.2 GHz	8	mK/K	2	95%	Yes			432
						Waveguide designation	R70								
RF noise: noise temperature in waveguides	Noise source	Radiometer	600	1000000	K	Frequency	8.2 GHz to 12.4 GHz	6	mK/K	2	95%	Yes			433
						Waveguide designation	R100								
RF noise: noise temperature in waveguides	Noise source	Radiometer	600	1000000	K	Frequency	12.4 GHz to 18 GHz	7	mK/K	2	95%	Yes			434
						Waveguide designation	R140								
RF noise: noise temperature in waveguides	Noise source	Radiometer	77	1E+07	K	Frequency	18 GHz to 26.5 GHz	11	mK/K	2	95%	Yes			435
						Waveguide designation	R220								
RF noise: noise temperature in waveguides	Noise source	Radiometer	77	1E+07	K	Frequency	26.5 GHz to 40 GHz	10	mK/K	2	95%	Yes			436
						Waveguide designation	R320								
RF noise: noise temperature in waveguides	Noise source	Radiometer	77	1E+07	K	Frequency	33 GHz to 50 GHz	11	mK/K	2	95%	Yes			437

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Calibration or Measurement Services			Measurand Level or Range			Measurement Conditions/Independent variables		Expanded Uncertainty							
Quantity	Instrument or artifact	Instrument Type or Method	Minimum value	Maximum value	units	Parameter	Specifications	Value	Units	Coverage Factor	Level of Confidence	Is the expanded uncertainty a relative one?	Uncertainty matrix	Comments	NMI Service Identifier
						Waveguide designation	R400								
RF noise: noise temperature in waveguides	Noise source	Radiometer	77	1E+07	K	Frequency	50 GHz to 75 GHz	14	mK/K	2	95%	Yes			438
						Waveguide designation	R620								
RF noise: noise temperature in waveguides	Noise source	Radiometer	77	1E+07	K	Frequency	75 GHz to 110 GHz	25	mK/K	2	95%	Yes			439
						Waveguide designation	R900								
RF noise: amplifier noise parameters: forward receiver noise wave	Amplifiers	Radiometer	77	1E+07	K	Frequency	10 MHz to 18 GHz	150	mK/K	2	95%	Yes			440
						Connector type	GPC-7								
RF noise: amplifier noise parameters: reverse receiver noise wave	Amplifiers	Radiometer	77	1E+07	K	Frequency	10 MHz to 18 GHz	5	mK/K	2	95%	Yes			441
						Connector type	GPC-7								
RF noise: amplifier noise parameters: magnitude of complex correlation term	Amplifiers	Radiometer	77	1E+07	K	Frequency	10 MHz to 18 GHz	100	mK/K	2	95%	Yes			442
						Connector type	GPC-7								
RF noise: amplifier noise parameters: phase of complex correlation term	Amplifiers	Radiometer	-180	180	°	Frequency	10 MHz to 18 GHz	50E-03		2	95%	Yes			443
						Connector type	GPC-7								

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Calibration or Measurement Services			Measurand Level or Range			Measurement Conditions/Independent variables		Expanded Uncertainty							
Quantity	Instrument or artifact	Instrument Type or Method	Minimum value	Maximum value	units	Parameter	Specifications	Value	Units	Coverage Factor	Level of Confidence	Is the expanded uncertainty a relative one?	Uncertainty matrix	Comments	NMI Service Identifier
RF noise: phase noise	Oscillators, 2 port devices	Phase detector	0	-170	dBc	Carrier frequency	10 MHz to 18 GHz	1.9	dB	2	95%	No			444
						Offset frequency	up to 40 MHz								
						Transmission medium	coaxial								
Antenna properties: antenna factor	Linear dipole	Standard antenna method	-30	80	dB(1/m)	Environment	defined height	0.35	dB	2	95%	No			445
						Frequency	20 MHz to 500 MHz								
						Frequency	20 MHz to 100 MHz								
Antenna properties: antenna factor	Linear dipole	Standard antenna method	-30	80	dB(1/m)	Environment	free-space	0.7	dB	2	95%	No			446
						Frequency	20 MHz to 100 MHz								
						Frequency	100 MHz to 500 MHz								
Antenna properties: antenna factor	Linear dipole	Standard antenna method	-30	80	dB(1/m)	Environment	free-space	0.5	dB	2	95%	No			447
						Frequency	100 MHz to 500 MHz								
						Frequency	500 MHz to 1000 MHz								
Antenna properties: antenna factor	Linear dipole	Standard antenna method	-30	80	dB(1/m)	Environment	horizontal above ground plane or free-space	0.5	dB	2	95%	No			448
						Frequency	500 MHz to 1000 MHz								
						Frequency	700 MHz to 1700 MHz								
Antenna properties: antenna factor	Biconical antenna	Standard antenna method	-30	80	dB(1/m)	Environment	free-space or defined height	0.5	dB	2	95%	No			450
						Frequency	20 MHz to 300 MHz								
						Frequency	80 MHz to 200 MHz								
Antenna properties: antenna factor	Log antenna	Three antenna method	-30	80	dB(1/m)	Environment	defined height up to 2.5 m	1	dB	2	95%	No			451
						Frequency	80 MHz to 200 MHz								

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Calibration or Measurement Services			Measurand Level or Range			Measurement Conditions/Independent variables		Expanded Uncertainty							
Quantity	Instrument or artifact	Instrument Type or Method	Minimum value	Maximum value	units	Parameter	Specifications	Value	Units	Coverage Factor	Level of Confidence	Is the expanded uncertainty a relative one?	Uncertainty matrix	Comments	NMI Service Identifier
Antenna properties: antenna factor	Log antenna	Three antenna method	-30	80	dB(1/m)	Environment	free-space	0.5	dB	2	95%	No			452
						Frequency	80 MHz to 5000 MHz								
Antenna properties: antenna factor	Bilog antenna	Standard antenna method up to 200 MHz then three antenna method	-30	80	dB(1/m)	Environment	free-space	0.7	dB	2	95%	No			453
						Frequency	20 MHz to 2000 MHz								
Antenna properties: antenna factor	Log spiral antenna	Three antenna method	-30	80	dB(1/m)	Environment	free-space	1	dB	2	95%	No			454
						Frequency	100 MHz to 1000 MHz								
Antenna properties: antenna factor	Horn antenna	Three antenna method	-30	80	dB(1/m)	Environment	free-space	1	dB	2	95%	No			455
						Frequency	200 MHz to 2000 MHz								
Antenna properties: antenna factor	Rod antenna	Standard antenna method or calculable field in GTEM cell	-30	80	dB(1/m)	Environment	free-field	1.5	dB	2	95%	No			456
						Frequency	100 Hz to 10 MHz								
Antenna properties: antenna factor	Rod antenna	Standard antenna method or calculable field in GTEM cell	-30	80	dB(1/m)	Environment	free-field	1	dB	2	95%	No			457
						Frequency	10 MHz to 100 MHz								
Antenna properties: antenna gain	Horn antennas	3 antenna extrapolation technique	0	21	dB	Frequency	2.6 GHz to 3.95 GHz	0.08	dB	2	95%	No			458
						Feed type	waveguide R32								

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Calibration or Measurement Services			Measurand Level or Range			Measurement Conditions/Independent variables		Expanded Uncertainty							
Quantity	Instrument or artifact	Instrument Type or Method	Minimum value	Maximum value	units	Parameter	Specifications	Value	Units	Coverage Factor	Level of Confidence	Is the expanded uncertainty a relative one?	Uncertainty matrix	Comments	NMI Service Identifier
Antenna properties: antenna gain	Horn antennas	3 antenna extrapolation technique	0	22	dB	Frequency	3.3 GHz to 4.9 GHz	0.07	dB	2	95%	No			459
						Feed type	waveguide R40								
Antenna properties: antenna gain	Horn antennas	3 antenna extrapolation technique	0	23	dB	Frequency	3.95 GHz to 5.85 GHz	0.07	dB	2	95%	No			460
						Feed type	waveguide R48								
Antenna properties: antenna gain	Horn antennas	3 antenna extrapolation technique	0	24	dB	Frequency	5.85 GHz to 8.2 GHz	0.05	dB	2	95%	No			461
						Feed type	waveguide R70								
Antenna properties: antenna gain	Horn antennas	3 antenna extrapolation technique	0	25	dB	Frequency	7.05 GHz to 10.0 GHz	0.05	dB	2	95%	No			462
						Feed type	waveguide R84								
Antenna properties: antenna gain	Horn antennas	3 antenna extrapolation technique	0	26	dB	Frequency	8.2 GHz to 12.4 GHz	0.05	dB	2	95%	No			463
						Feed type	waveguide R100								
Antenna properties: antenna gain	Horn antennas	3 antenna extrapolation technique	0	27	dB	Frequency	10.0 GHz to 15.0 GHz	0.05	dB	2	95%	No			464
						Feed type	waveguide R120								
Antenna properties: antenna gain	Horn antennas	3 antenna extrapolation technique	0	28	dB	Frequency	12.4 GHz to 18.0 GHz	0.04	dB	2	95%	No			465
						Feed type	waveguide R140								
Antenna properties: antenna gain	Horn antennas	3 antenna extrapolation technique	0	30	dB	Frequency	18.0 GHz to 26.5 GHz	0.04	dB	2	95%	No			466
						Feed type	waveguide R220								
Antenna properties: antenna gain	Horn antennas	3 antenna extrapolation technique	0	31	dB	Frequency	26.5 GHz to 40.0 GHz	0.04	dB	2	95%	No			467
						Feed type	waveguide R320								
Antenna properties: antenna gain	Horn antennas	3 antenna extrapolation technique	0	31	dB	Frequency	43.5 GHz to 45.5 GHz	0.05	dB	2	95%	No			468
						Feed type	waveguide R400								
Antenna properties: antenna gain	Horn antennas, log periodic	3 antenna extrapolation technique	0	28	dB	Frequency	1.0 GHz to 18.0 GHz	0.05	dB	2	95%	No			469

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Calibration or Measurement Services			Measurand Level or Range			Measurement Conditions/Independent variables		Expanded Uncertainty							
Quantity	Instrument or artifact	Instrument Type or Method	Minimum value	Maximum value	units	Parameter	Specifications	Value	Units	Coverage Factor	Level of Confidence	Is the expanded uncertainty a relative one?	Uncertainty matrix	Comments	NMI Service Identifier
						Feed type	coaxial 50 Ω GPC-7 or type N								
Antenna properties: antenna gain	Horn antennas, log periodic	3 antenna extrapolation technique	0	28	dB	Frequency	1.0 GHz to 26.5 GHz	0.05	dB	2	95%	No			470
						Feed type	coaxial 50 Ω GPC-3.5mm								
Antenna properties: reflection coefficient	Antennas with coaxial inputs	Network analyser	0	1		Environment	antenna radiating in free-space	0.05		2	95%	No			471
						Frequency	0.3 MHz to 6000 MHz								
Signal and pulse characteristics: pulse amplitude	Pulse generator	Calibrated oscilloscope	-500	500	mV			1.5	mV	2	95%	No			472.1
Signal and pulse characteristics: pulse amplitude aberrations (e.g. preshoot, overshoot)	Pulse generator	Calibrated oscilloscope	0	2	%	Measurement bandwidth	1 GHz to 50 GHz	0.5	%	2	95%	No	Aberrations given as % of amplitude		472.2
Signal and pulse characteristics: pulse amplitude aberrations (e.g. preshoot, overshoot)	Pulse generator	Calibrated oscilloscope	> 2	20	%	Measurement bandwidth	1 GHz to 8 GHz	1	%	2	95%	No	Aberrations given as % of amplitude		472.3
Signal and pulse characteristics: pulse amplitude aberrations (e.g. preshoot, overshoot)	Pulse generator	Calibrated oscilloscope	> 2	20	%	Measurement bandwidth	> 8 GHz to 50 GHz	2	%	2	95%	No	Aberrations given as % of amplitude		472.4
Signal and pulse characteristics: pulse settling	Pulse generator	Calibrated oscilloscope	0	5	%	Settling time after transition	1 ns to 10 ns	0.3	%	2	95%	No	Given as % of amplitude		472.5
Signal and pulse characteristics: pulse settling	Pulse generator	Calibrated oscilloscope	0	2	%	Settling time after transition	> 10 ns	0.1	%	2	95%	No	Given as % of amplitude		472.6

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Calibration or Measurement Services			Measurand Level or Range			Measurement Conditions/Independent variables		Expanded Uncertainty							
Quantity	Instrument or artifact	Instrument Type or Method	Minimum value	Maximum value	units	Parameter	Specifications	Value	Units	Coverage Factor	Level of Confidence	Is the expanded uncertainty a relative one?	Uncertainty matrix	Comments	NMI Service Identifier
Signal and pulse characteristics: pulse time parameters: risetime	Pulse generator	Calibrated oscilloscope	11	60	ps			1.4	ps	2	95%	No			473
Signal and pulse characteristics: pulse time parameters: risetime τ	Pulse generator, risetime τ	Calibrated oscilloscope	60	10000	ps			$(1.4 + 0.005 \tau), \tau$ in ps	ps	2	95%	No			474
Signal and pulse characteristics: pulse time parameters: risetime	Sampling oscilloscope	Calibrated electrical or optoelectronic pulse generator	7	50	ps			1.3	ps	2	95%	No			475
Signal and pulse characteristics: pulse time parameters: risetime	Sampling oscilloscope, risetime τ	Calibrated electrical or optoelectronic pulse generator	> 50	1000	ps			$(3.0 + 0.005 \tau), \tau$ in ps	ps	2	95%	No			476.1
Signal and pulse characteristics: pulse time parameters: risetime	Real-time digitising oscilloscope, risetime τ	Calibrated electrical pulse generator	300	10000	ps			$(20.0 + 0.002 \tau), \tau$ in ps	ps	2	95%	No			476.2
RF voltage and current: RF-DC transfer difference	AC/DC voltage transfer standard, thermal converter	Thermal converter "digital" bridge	1	1	V	Frequency	1 MHz to 100 MHz	51 to 2100	$\mu\text{V}/\text{V}$	2	95%	Yes	Matrix 2		132a
RF characteristic impedance: electrical parameters	Reference air lines	Air-gauge system	49.8	50.2	Ω	Line size	14 mm	0.03	Ω	2	95%	No		Conversion from mechanical to electrical: suitable reference is DES report 114, 1992	503
						Impedance	50 Ω								

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Calibration or Measurement Services			Measurand Level or Range			Measurement Conditions/Independent variables		Expanded Uncertainty							
Quantity	Instrument or artifact	Instrument Type or Method	Minimum value	Maximum value	units	Parameter	Specifications	Value	Units	Coverage Factor	Level of Confidence	Is the expanded uncertainty a relative one?	Uncertainty matrix	Comments	NMI Service Identifier
RF characteristic impedance: electrical parameters	Reference air lines	Air-gauge system	49.6	50.4	Ω	Line size	7 mm	0.03	Ω	2	95%	No		Conversion from mechanical to electrical: suitable reference is DES report 114, 1992	504
						Impedance	50 Ω								
RF characteristic impedance: electrical parameters	Reference air lines	Air-gauge system	49.2	50.8	Ω	Line size	3.5 mm	0.1	Ω	2	95%	No		Conversion from mechanical to electrical: suitable reference is DES report 114, 1992	505
						Impedance	50 Ω								
RF characteristic impedance: electrical parameters	Reference air lines	Air-gauge system	48.9	50.9	Ω	Line size	2.92 mm	0.15	Ω	2	95%	No		Conversion from mechanical to electrical: suitable reference is DES report 114, 1992	506
						Impedance	50 Ω								
RF characteristic impedance: electrical parameters	Reference air lines	Air-gauge system	48.9	51.4	Ω	Line size	2.4 mm	0.2	Ω	2	95%	No		Conversion from mechanical to electrical: suitable reference is DES report 114, 1992	507
						Impedance	50 Ω								

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Calibration or Measurement Services			Measurand Level or Range			Measurement Conditions/Independent variables		Expanded Uncertainty							
Quantity	Instrument or artifact	Instrument Type or Method	Minimum value	Maximum value	units	Parameter	Specifications	Value	Units	Coverage Factor	Level of Confidence	Is the expanded uncertainty a relative one?	Uncertainty matrix	Comments	NMI Service Identifier
RF characteristic impedance: electrical parameters	Reference air lines	Air-gauge and laser gauge system	48.7	51.9	Ω	Line size	1.85 mm	0.25	Ω	2	95%	No		Conversion from mechanical to electrical: suitable reference is DES report 114, 1992	508
						Impedance	50 Ω								
Electrical conductivity: metallic materials	Reference material	Eddy-current measurement, AC bridge	2	60	MS/m	Frequency	10 kHz to 100 kHz	7E-03		2	95%	Yes			509
Electrical conductivity: metallic materials	Instrument	AC comparison with reference material	2	60	MS/m	Frequency	10 kHz to 100 kHz	7E-03		2	95%	Yes			510.1
Electrical conductivity: liquids	Conductivity meters	Measurement using calibrated solutions	0.01	1	S/m	Temperature	20 °C to 25 °C	3E-03		2	95%	Yes			510.2
Dielectric properties: relative permittivity: real component	Liquid materials, ϵ'	Two terminal admittance cell and bridge	1	80		Frequency	10 kHz to 1 MHz	0.002 ϵ'		2	95%	No			511
						Temperature	5 °C to 50 °C								
Dielectric properties: relative permittivity: real component	Solid materials, ϵ'	Three terminal admittance cell and bridge	1	30		Frequency	1 kHz to 3 MHz	0.002 ϵ'		2	95%	No		This CMC is related to the next one	512
						Temperature	5 °C to 50 °C								
Dielectric properties: loss tangent	Solid materials, $\tan\delta$	Three terminal admittance cell and bridge	0.00002	1		Frequency	1 kHz to 3 MHz	Q[0.02 $\tan\delta$, 0.00002]		2	95%	No		This CMC is related to the previous one	518
						Temperature	20 °C to 25 °C								
Dielectric properties: relative permittivity: real component	Solid materials, ϵ'	14 mm coaxial line and network analyser	1	30		Frequency	50 MHz to 6 GHz	0.004 ϵ'		2	95%	No		This CMC is related to the next one	513
						Temperature	20 °C to 25 °C								

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Calibration or Measurement Services			Measurand Level or Range			Measurement Conditions/Independent variables		Expanded Uncertainty							
Quantity	Instrument or artifact	Instrument Type or Method	Minimum value	Maximum value	units	Parameter	Specifications	Value	Units	Coverage Factor	Level of Confidence	Is the expanded uncertainty a relative one?	Uncertainty matrix	Comments	NMI Service Identifier
Dielectric properties: loss tangent	Solid materials, $\tan\delta$	14 mm coaxial line and network analyser	0.01	1		Frequency	50 MHz to 6 GHz	$Q[0.02 \tan\delta, 0.005]$		2	95%	No		This CMC is related to the previous one	519
						Temperature	20 °C to 25 °C								
Dielectric properties: relative permittivity: real component	Solid materials, ϵ'	7 mm coaxial line and network analyser	1	30		Frequency	100 MHz to 18 GHz	$0.005\epsilon'$		2	95%	No		This CMC is related to the next one	514
						Temperature	20 °C to 25 °C								
Dielectric properties: loss tangent	Solid materials, $\tan\delta$	7 mm coaxial line and network analyser	0.01	1		Frequency	100 MHz to 18 GHz	$Q[0.02 \tan\delta, 0.005]$		2	95%	No		This CMC is related to the previous one	520
						Temperature	20 °C to 25 °C								
Dielectric properties: relative permittivity: real component	Liquid materials, ϵ'	14 mm coaxial line and network analyser	1	50		Frequency	50 MHz to 6 GHz	$0.003\epsilon'$		2	95%	No		This CMC is related to the next one	515
						Temperature	20 °C to 25 °C								
Dielectric properties: loss tangent	Liquid materials, $\tan\delta$	14 mm coaxial line and network analyser	0.01	1		Frequency	50 MHz to 6 GHz	$Q[0.02 \tan\delta, 0.005]$		2	95%	No		This CMC is related to the previous one	521
						Temperature	20 °C to 25 °C								
Dielectric properties: relative permittivity: real component	Liquid materials, malleable solid materials: ϵ'	14 mm coaxial sensor probe and network analyser	1	80		Frequency	10 MHz to 5 GHz	$0.005\epsilon'$		2	95%	No		This CMC is related to the next one	516
						Temperature	20 °C to 25 °C								
Dielectric properties: loss tangent	Liquid materials, malleable solid materials: $\tan\delta$	14 mm coaxial sensor probe and network analyser	0.01	1		Frequency	10 MHz to 5 GHz	$Q[0.05 \tan\delta, 0.01]$		2	95%	No		This CMC is related to the previous one	522
						Temperature	20 °C to 25 °C								
Dielectric properties: relative permittivity: real component	Solid materials, ϵ'	Open resonator and network analyser	1	50		Frequency	36 GHz and 72 GHz	$0.002\epsilon'$		2	95%	No		This CMC is related to the next one	517

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Calibration or Measurement Services			Measurand Level or Range			Measurement Conditions/Independent variables		Expanded Uncertainty							
Quantity	Instrument or artifact	Instrument Type or Method	Minimum value	Maximum value	units	Parameter	Specifications	Value	Units	Coverage Factor	Level of Confidence	Is the expanded uncertainty a relative one?	Uncertainty matrix	Comments	NMI Service Identifier
Dielectric properties: loss tangent	Solid materials, $\tan\delta$	Open resonator and network analyser	0.00001	0.002		Temperature	20 °C to 25 °C							This CMC is related to the previous one	524
Dielectric properties: loss tangent	Solid materials, $\tan\delta$	Two terminal resonant cell, Q-meter or bridge	0.00002	0.05		Frequency	36 GHz and 72 GHz	Q[0.03 $\tan\delta$, 0.00001]		2	95%	No			523
Soft magnetic sheet and powder materials: specific total power loss	Epstein, ring and single sheet sample, non-oriented material	IEC 60404 part 2, IEC 60404 part 3	0.02	120	W/kg	Temperature	50 Hz to 60 Hz	6.5	1E-03	2	95%	Yes			525
Soft magnetic sheet and powder materials: specific total power loss	Epstein, ring and single sheet sample, non-oriented material	IEC 60404 part 2, IEC 60404 part 3	0.02	120	W/kg	Polarisation	< 1.3 T								526
Soft magnetic sheet and powder materials: specific total power loss	Epstein and ring sample non-oriented material	IEC 60404 part 10	0.02	120	W/kg	Polarisation	1.3 T to 1.7 T								527
Soft magnetic sheet and powder materials: specific total power loss	Epstein and ring sample non-oriented material	IEC 60404 part 10	0.02	120	W/kg	Frequency	400 Hz	7	1E-03	2	95%	Yes			528
						Polarisation	< 1.3 T								
						Polarisation	1.3 T to 1.7 T								

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Calibration or Measurement Services			Measurand Level or Range			Measurement Conditions/Independent variables		Expanded Uncertainty							
Quantity	Instrument or artifact	Instrument Type or Method	Minimum value	Maximum value	units	Parameter	Specifications	Value	Units	Coverage Factor	Level of Confidence	Is the expanded uncertainty a relative one?	Uncertainty matrix	Comments	NMI Service Identifier
Soft magnetic sheet and powder materials: specific total power loss	Epstein, ring and single sheet sample, oriented material	IEC 60404 part 2, IEC 60404 part 3	0.02	120	W/kg	Frequency range	50 Hz to 60 Hz	6.5	1E-03	2	95%	Yes			529
						Polarisation	< 1.7 T								
Soft magnetic sheet and powder materials: specific total power loss	Epstein, ring and single sheet sample, oriented material	IEC 60404 part 2, IEC 60404 part 3	0.02	120	W/kg	Frequency range	50 Hz to 60 Hz	7.5	1E-03	2	95%	Yes			530
						Polarisation	1.7 T to 1.8 T								
Soft magnetic sheet and powder materials: specific total power loss	Epstein and ring sample, oriented material	IEC 60404 part 10	0.02	120	W/kg	Frequency	400 Hz	7	1E-03	2	95%	Yes			531
						Polarisation	< 1.7 T								
Soft magnetic sheet and powder materials: specific total power loss	Epstein and ring sample, oriented material	IEC 60404 part 10	0.02	120	W/kg	Frequency	400 Hz	18	1E-03	2	95%	Yes			532.1
						Polarisation range	1.7 T to 1.8 T								
Soft magnetic sheet and powder materials: specific total power loss	Ring sample	FDIS IEC 60404 part 6	0.02	120	W/kg	Frequency	400 Hz to 100 kHz	6.5	1E-03	2	95%	Yes			532.2
						Polarisation range	< 100 mT								

Electricity and Magnetism, United Kingdom, NPL (National Physical Laboratory)

Calibration or Measurement Services			Measurand Level or Range			Measurement Conditions/Independent variables		Expanded Uncertainty							
Quantity	Instrument or artifact	Instrument Type or Method	Minimum value	Maximum value	units	Parameter	Specifications	Value	Units	Coverage Factor	Level of Confidence	Is the expanded uncertainty a relative one?	Uncertainty matrix	Comments	NMI Service Identifier
Soft magnetic sheet and powder materials: peak value of AC magnetic polarisation	Epstein, ring and single sheet sample, oriented and non-oriented material	IEC 60404 part 2, IEC 60404 part 3	0.5	1.9	T	Frequency range	50 Hz to 400 Hz	1.6	1E-03	2	95%	Yes			533.1
Soft magnetic sheet and powder materials: peak value of AC magnetic polarisation	Ring sample	FDIS IEC 60404 part 6	1	100	mT	Frequency range	400 Hz to 100 kHz	1.6	1E-03	2	95%	Yes			533.2
Soft magnetic sheet and powder materials: specific apparent power	Epstein, ring and single sheet sample, non-oriented material	IEC 60404 part 2, IEC 60404 part 3	0.06	400	VA/kg	Frequency range	50 Hz to 60 Hz	11	1E-03	2	95%	Yes			534
					Polarisation	< 1.3 T									
Soft magnetic sheet and powder materials: specific apparent power	Epstein, ring and single sheet sample, non-oriented material	IEC 60404 part 2, IEC 60404 part 3	0.06	400	VA/kg	Frequency range	50 Hz to 60 Hz	15	1E-03	2	95%	Yes			535
					Polarisation range	1.3 T to 1.5 T									
Soft magnetic sheet and powder materials: specific apparent power	Epstein, ring and single sheet sample, non-oriented material	IEC 60404 part 2, IEC 60404 part 3	0.06	400	VA/kg	Frequency range	50 Hz to 60 Hz	26	1E-03	2	95%	Yes			536
					Polarisation range	1.5 T to 1.7 T									
Soft magnetic sheet and powder materials: specific apparent power	Epstein, ring and single sheet sample, oriented material	IEC 60404 part 2, IEC 60404 part 3	0.06	400	VA/kg	Frequency range	50 Hz to 60 Hz	11	1E-03	2	95%	Yes			537

Electricity and Magnetism, United Kingdom, NPL (National Physical Laboratory)

Calibration or Measurement Services			Measurand Level or Range			Measurement Conditions/Independent variables		Expanded Uncertainty							
Quantity	Instrument or artifact	Instrument Type or Method	Minimum value	Maximum value	units	Parameter	Specifications	Value	Units	Coverage Factor	Level of Confidence	Is the expanded uncertainty a relative one?	Uncertainty matrix	Comments	NMI Service Identifier
						Polarisation	< 1.5 T								
Soft magnetic sheet and powder materials: specific apparent power	Epstein, ring and single sheet sample, oriented material	IEC 60404 part 2, IEC 60404 part 3	0.06	400	VA/kg	Frequency range	50 Hz to 60 Hz	26	1E-03	2	95%	Yes			538.1
						Polarisation range	1.5 T to 1.8 T								
Soft magnetic sheet and powder materials: specific apparent power	Ring sample	FDIS IEC 60404 part 6	0.06	400	VA/kg	Frequency	400 Hz to 100 kHz	11	1E-03	2	95%	Yes			538.2
						Polarisation range	< 100 mT								
Soft magnetic sheet and powder materials: peak permeability	Epstein, ring and single sheet sample, oriented and non-oriented material	IEC 404 part 2, IEC 404 part 3	35000	200000		Frequency range	50 Hz to 60 Hz	4.5	1E-03	2	95%	Yes			539.1
						Polarisation range	0.5 T to 1.9 T								
Soft magnetic sheet and powder materials: peak permeability	Ring sample	FDIS IEC 60404 part 6	35000	200000		Frequency	400 Hz to 100 kHz	4.5	1E-03	2	95%	Yes			539.2
						Polarisation range	< 100 mT								
Soft magnetic bulk materials: magnetic polarisation	Ring specimen	IEC 60404 part 4, hysteresis loop, magnetization curve	0.05	2.2	T	Magnetic field strength	0.1 kA/m to ± 10 kA/m	4	1E-03	2	95%	Yes			540
Soft magnetic bulk materials: magnetic polarisation	Bar specimen	IEC 60404 part 4, hysteresis loop, magnetization curve	0.05	2.2	T	Magnetic field strength	1 kA/m to ± 200 kA/m	4	1E-03	2	95%	Yes			541

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Calibration or Measurement Services			Measurand Level or Range			Measurement Conditions/Independent variables		Expanded Uncertainty							
Quantity	Instrument or artifact	Instrument Type or Method	Minimum value	Maximum value	units	Parameter	Specifications	Value	Units	Coverage Factor	Level of Confidence	Is the expanded uncertainty a relative one?	Uncertainty matrix	Comments	NMI Service Identifier
Soft magnetic bulk materials: magnetic field strength	Ring specimen	IEC 60404 part 4, hysteresis loop, magnetization curve	0.1	10	kA/m			4	1E-03	2	95%	Yes			542
Soft magnetic bulk materials: magnetic field strength	Bar specimen	IEC 60404 part 4, hysteresis loop, magnetization curve	1	200	kA/m			4	1E-03	2	95%	Yes			543
Soft magnetic bulk materials: coercive field strength	Soft magnetic material	Vibrating coil magnetometer: IEC 60404 part 7	5	500	A/m			3	1E-03	2	95%	Yes			544
Soft magnetic bulk materials: permeability	Soft magnetic material, closed magnetic circuit	Flux integrator	500	20000				6	1E-03	2	95%	Yes			545
Feebly magnetic, paramagnetic and diamagnetic materials: DC relative magnetic permeability	Low permeability material	BS 5884. Extraction method using calibrated integrator and calibrated coil system	1.0002	1.001				0.01	1E-03	2	95%	Yes			546
Feebly magnetic, paramagnetic and diamagnetic materials: DC relative magnetic permeability	Low permeability material	BS 5884. Extraction method using calibrated integrator and calibrated coil system	1.001	1.01				0.02	1E-03	2	95%	Yes			547
Feebly magnetic, paramagnetic and diamagnetic materials: DC relative magnetic permeability	Low permeability material	BS 5884. Extraction method using calibrated integrator and calibrated coil system	1.01	1.1				0.2	1E-03	2	95%	Yes			548

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Calibration or Measurement Services			Measurand Level or Range			Measurement Conditions/Independent variables		Expanded Uncertainty							
Quantity	Instrument or artifact	Instrument Type or Method	Minimum value	Maximum value	units	Parameter	Specifications	Value	Units	Coverage Factor	Level of Confidence	Is the expanded uncertainty a relative one?	Uncertainty matrix	Comments	NMI Service Identifier
Feebly magnetic, paramagnetic and diamagnetic materials: DC relative magnetic permeability	Low permeability material	BS 5884. Extraction method using calibrated integrator and calibrated coil system	1.1	2.5				1	1E-03	2	95%	Yes			549
Feebly magnetic, paramagnetic and diamagnetic materials: DC relative magnetic permeability	Low relative magnetic permeability measuring instruments	Comparison with reference material	1.001	2.5				1	1E-03	2	95%	Yes			550
Hard magnetic materials: remanent magnetic flux density	Material	IEC 60404 part 5	0.02	2	T			3	mT/T	2	95%	Yes			551
Hard magnetic materials: coercive field strength H_{CB}	Material	IEC 60404 part 5	0.03	1.6	MA/m			4	1E-03	2	95%	Yes			552
Hard magnetic materials: coercive field strength H_{CJ}	Material	IEC 60404 part 5	0.03	1.6	MA/m			4	1E-03	2	95%	Yes			553
Hard magnetic materials: maximum energy product: $(B \cdot H)_{max}$	Material	IEC 60404 part 5	1	400	kJ/m^3			5	1E-03	2	95%	Yes			554.1
Hard magnetic materials: magnetic moment	Material	IEC 60404 part 14	0.06	1000	Am^2			1.1	1E-03	2	95%	Yes			554.2
Hard magnetic materials: magnetic flux density	Material	IEC 60404 part 5: demagnetisation curve	0.02	2	T	Magnetic field strength	up to -1.6 MA/m	4	mT/T	2	95%	Yes			555

Electricity and Magnetism, United Kingdom, NPL (National Physical Laboratory)

Calibration or Measurement Services			Measurand Level or Range			Measurement Conditions/Independent variables		Expanded Uncertainty							
Quantity	Instrument or artifact	Instrument Type or Method	Minimum value	Maximum value	units	Parameter	Specifications	Value	Units	Coverage Factor	Level of Confidence	Is the expanded uncertainty a relative one?	Uncertainty matrix	Comments	NMI Service Identifier
Hard magnetic materials: magnetic polarisation	Material	IEC 60404 part 5: demagnetisation curve	0.02	2	T	Magnetic field strength	up to -1.6 MA/m	4	mT/T	2	95%	Yes			556

Electricity and Magnetism, United Kingdom, NPL (National Physical Laboratory)**Uncertainty table: Matrix 1**

AC resistance: real component, NPL Internal Identifier: 33

	40 Hz	75 Hz	400 Hz	1000 Hz	1592 Hz	2 kHz	3 kHz	5 kHz	10 kHz	20 kHz
1 Ω	5.0	5.0	5.0	4.0	4.0	4.0	5.0	6.0	15.0	50.0
10 Ω	1.5	1.0	0.5	0.5	0.5	0.5	1.2	1.8	6.0	25.0
25 Ω	1.0	1.0	0.5	0.5	0.5	0.5	1.2	1.8	6.0	25.0
100 Ω	1.0	1.0	0.6	0.6	0.6	0.8	1.5	1.8	6.0	25.0
1 kΩ	1.0	1.0	0.5	0.5	0.5	0.5	1.2	1.8	6.0	25.0
10 kΩ	1.0	1.0	0.5	0.5	0.5	0.5	1.2	1.8	8.0	25.0

The expanded uncertainties given in this table are expressed in $\mu\Omega/\Omega$

Electricity and Magnetism, United Kingdom, NPL (National Physical Laboratory)**Uncertainty table: Matrix 2**

AC voltage: AC-DC transfer difference at low voltages, NPL Internal Identifier: 141

AC voltage: AC-DC transfer difference at medium voltages, NPL Internal Identifier: 132

AC voltage: AC-DC transfer difference at higher voltages, NPL Internal Identifier: 159

RF voltage and current: RF-DC transfer difference, NPL Internal Identifier: 132a

	10 Hz	20 Hz to 5 kHz	10 kHz	20 kHz	50 kHz	100 kHz	200 kHz	300 kHz	500 kHz	700 kHz	1 MHz	3MHz	10 MHz	20 MHz	30 MHz	50 MHz	70 MHz	100 MHz
1 mV	26	26	26	28	36	58	100	158	258	462	776	-	-	-	-	-	-	-
2 mV	26	26	26	26	30	47	80	119	191	306	485	-	-	-	-	-	-	-
5 mV	26	26	26	26	30	45	77	108	177	270	437	-	-	-	-	-	-	-
10 mV	26	26	26	26	30	42	72	103	165	242	374	-	-	-	-	-	-	-
20 mV	26	26	26	26	30	42	71	102	162	230	337	-	-	-	-	-	-	-
70 mV	26	26	26	26	30	41	70	100	160	227	332	-	-	-	-	-	-	-
100 mV / 200 mV	6	6	6	6	8	13	24	36	58	82	121	-	-	-	-	-	-	-
300 mV	5	5	5	5	6	11	20	29	48	67	96	-	-	-	-	-	-	-
500 mV	5	5	5	5	6	9	16	23	38	54	76	-	-	-	-	-	-	-
1 V	5	5	5	5	6	7	12	16	25	37	51	51	64	140	300	600	1100	2100
2 V, 3 V	5	5	5	5	6	9	12	17	26	38	-	-	-	-	-	-	-	-
4 V, 5 V	5	5	5	5	5	6	7	9	13	20	31	-	-	-	-	-	-	-
5 V	5	5	5	5	5	6	7	9	13	20	31	-	-	-	-	-	-	-
10 V	6	6	6	6	6	7	9	10	15	23	33	-	-	-	-	-	-	-
20 V	7	7	7	7	7	7	10	13	16	27	35	-	-	-	-	-	-	-
30 V	7	7	7	7	7	8	12	-	-	-	-	-	-	-	-	-	-	-
50 V	8	7	7	7	8	11	15	-	-	-	-	-	-	-	-	-	-	-
70 V	8	7	7	7	8	12	15	-	-	-	-	-	-	-	-	-	-	-
100 V	8	7	7	7	8	11	15	-	-	-	-	-	-	-	-	-	-	-
200 V / 300 V	9	8	8	10	13	22	-	-	-	-	-	-	-	-	-	-	-	-
500 V	14	10	11	14	23	42	-	-	-	-	-	-	-	-	-	-	-	-
600 V / 700 V	14	10	11	18	28	52	-	-	-	-	-	-	-	-	-	-	-	-
1000 V	14	10	12	23	32	62	-	-	-	-	-	-	-	-	-	-	-	-

The expanded uncertainties given in this table are expressed in $\mu\text{V/V}$

Electricity and Magnetism, United Kingdom, NPL (National Physical Laboratory)**Uncertainty table: Matrix 3**

AC voltage up to 1000 V: meters, NPL Internal Identifier: 183.2

	10 Hz	20 Hz to 5 kHz	10 kHz	20 kHz	50 kHz	100 kHz	200 kHz	300 kHz	500 kHz	700 kHz	1 MHz
500 mV	7	7	7	7	10	13	20	29	43	62	86
1 V	7	7	7	9	11	13	17	22	30	43	59
2 V	7	7	7	7	9	11	14	18	22	31	43
3 V	7	7	7	7	7	8	11	15	20	29	40
4 V / 5 V	7	7	7	7	7	7	9	11	15	22	33
10 V	8	7	7	7	7	8	10	11	17	25	34
20 V	8	8	8	8	8	9	11	14	18	28	37
30 V	8	8	8	8	8	9	13	-	-	-	-
50 V / 70 V / 100 V	9	9	9	9	9	12	16	-	-	-	-
200 V / 300 V	10	9	9	11	14	22	-	-	-	-	-
500 V	14	11	12	15	23	42	-	-	-	-	-
600 V / 700 V	14	11	12	19	28	52	-	-	-	-	-
1000 V	14	11	12	23	33	62	-	-	-	-	-

The expanded uncertainties given in this table are expressed in $\mu\text{V/V}$

Electricity and Magnetism, United Kingdom, NPL (National Physical Laboratory)**Uncertainty table: Matrix 4**

AC current: AC-DC transfer difference, NPL Internal Identifier: 242

	10 Hz	20 Hz	40 Hz	100 Hz	400 Hz	1kHz	2 kHz	5 kHz	10 kHz	20 kHz	50 kHz	70 kHz	100 kHz
1 mA	31	30	30	30	30	30	30	30	30	31	31	33	35
2 mA	17	17	16	16	16	16	16	16	17	18	19	22	25
3 mA	12	12	12	12	12	12	12	12	13	14	16	19	22
5 mA	11	10	10	10	10	10	10	10	12	13	15	19	22
10 mA	11	10	10	10	10	10	10	10	12	13	15	19	22
20 mA	11	10	10	10	10	10	10	10	12	13	15	19	22
30 mA	11	10	10	10	10	10	10	10	12	13	15	19	22
50 mA	11	11	10	11	10	11	10	12	11	11	14	14	23
0.1 A	14	13	12	12	12	12	12	12	12	13	20	23	42
0.2 A	23	20	16	16	16	16	16	16	16	17	28	33	61
0.25 A	23	20	16	16	16	16	16	16	16	17	28	33	61
0.3 A	30	26	16	17	16	18	16	17	15	24	43	52	81
0.5 A	30	26	16	17	16	18	16	17	15	24	43	52	81
1 A	38	31	19	19	19	20	17	18	17	33	53	62	101
2 A	47	37	22	20	21	22	20	21	20	43	63	83	122
2.5 A	47	37	22	20	21	22	20	21	20	43	63	83	122
3 A	55	43	25	23	24	24	23	21	22	53	83	102	162
5 A	55	43	25	23	24	24	23	21	22	53	83	102	162
10 A	63	49	27	25	26	26	25	26	23	62	102	122	202
20 A	72	56	31	28	30	29	28	29	28	73	122	143	243

The expanded uncertainties given in this table are expressed in $\mu\text{A}/\text{A}$

Uncertainty table: Matrix 5

Capacitance: low loss capacitors, NPL Internal Identifier: 73

	1 kHz, 1.592 kHz	10 kHz	100 kHz	1 MHz
1 pF	4	-	-	-
10 pF to 100 pF	3	-	-	-
1 nF	3	5	200	2000

The expanded uncertainties given in this table are expressed in $\mu\text{F/F}$

Electricity and Magnetism, United Kingdom, NPL (National Physical Laboratory)



Uncertainty table: Matrix 5a

Capacitance: dielectric capacitors, NPL Internal Identifier: 75

	1 kHz, 1.592 kHz	100 kHz	300 kHz	500 kHz	700 kHz	1000 kHz
1 nF	-	2	23	78	155	221
10 nF	30	3	33	110	219	313
100 nF	30	5	47	155	310	443
1000 nF	60	7	66	219	438	626

The expanded uncertainties given in this table are expressed in $\mu\text{F/F}$

Uncertainty table: Matrix 6

Capacitance: transformed capacitors, NPL Internal Identifier: 80

	100 Hz	120 Hz	1 kHz
1 μF	1	1	1
10 μF	2	2	3
100 μF	2	2	5
1 mF	3	3	5
10 mF	3	3	5
100 mF	3	3	-
1 F	10	10	-

The expanded uncertainties given in this table are expressed in mF/F

Electricity and Magnetism, United Kingdom, NPL (National Physical Laboratory)



Uncertainty table: Matrix 7a

Capacitance: dissipation factor for low loss capacitors, NPL Internal Identifier: 90

	1 kHz, 1.592 kHz	10 kHz	100 kHz	1 MHz
1 pF	1.00E-05	-	-	-
10 pF to 100 pF	7.00E-06	-	-	-
1 nF	7.00E-06	2.00E-05	1.00E-04	1.00E-03

The expanded uncertainties given in this table are dimensionless

Electricity and Magnetism, United Kingdom, NPL (National Physical Laboratory)



Uncertainty table: Matrix 7b

Capacitance: dissipation factor for dielectric capacitors, NPL Internal Identifier: 92

	1 kHz, 1.592 kHz	100 kHz	300 kHz	500 kHz	700 kHz	1000 kHz
1 nF	-	3	35	116	231	330
10 nF	2.0	5	49	164	327	467
100 nF	2.0	7	69	231	463	661
1000 nF	2.0	10	98	327	654	935

The expanded uncertainties given in this table are expressed in 1E-06

Electricity and Magnetism, United Kingdom, NPL (National Physical Laboratory)



Uncertainty table: Matrix 7c

Capacitance: dissipation factor for transformed capacitors, NPL Internal Identifier: 96

	100 Hz, 120 Hz	1 kHz
1 μF	0.001	0.001
10 μF	0.001	0.001
100 μF	0.001	0.001
1 mF	0.001	0.002
10 mF	0.001	0.005
100 mF	0.003	-
1 F	0.01	-

The expanded uncertainties given in this table are dimensionless

Electricity and Magnetism, United Kingdom, NPL (National Physical Laboratory)**Uncertainty table: Matrix 8**

Inductance: self inductance, low values, NPL Internal Identifier: 102

Inductance: self inductance, intermediate values, NPL Internal Identifier: 112

Inductance: self inductance, high values, NPL Internal Identifier: 126

	20 Hz	50 Hz	100 Hz	400 Hz	1000 Hz	1592 Hz	2000 Hz	5000 Hz	10000 Hz
1 µH	-	-	20313	20313	1237	1237	1237	2502	3478
2 µH	-	-	10089	10089	1237	1237	1237	2226	2995
3 µH	-	-	6073	6073	1145	1145	1145	2153	2638
5 µH	-	-	3500	3500	603	610	610	1094	1504
10 µH	3509	2506	1980	1980	316	341	341	616	923
20 µH	1753	1257	982	982	159	159	159	315	459
30 µH	1175	841	663	663	114	113	113	187	257
50 µH	699	501	396	396	97	105	105	156	206
100 µH	301	201	152	152	75	80	80	146	195
200 µH	250	176	102	102	76	84	84	124	173
300 µH	250	182	99	99	83	84	84	132	166
500 µH	219	166	99	99	83	83	83	132	166
1 mH	180	152	95	95	77	77	77	120	150
2 mH	177	152	99	99	76	77	77	123	150
3 mH	182	150	99	99	84	84	84	118	150
5 mH	182	160	100	100	80	81	81	120	151
10 mH	177	152	99	99	74	74	74	116	147
20 mH	177	151	99	99	77	77	77	123	148
30 mH	182	149	99	99	83	83	83	118	150
50 mH	200	161	99	99	80	80	80	160	200
100 mH	185	150	85	85	70	70	70	140	200
200 mH	226	199	89	89	74	74	74	202	301
400 mH	238	201	88	88	75	75	75	201	376
500 mH	235	206	91	91	77	80	80	201	395
1 H	147	147	83	83	74	71	71	202	404
2 H	135	110	83	83	69	71	71	378	803
5 H	135	111	86	86	80	83	83	-	-
10 H	133	109	83	83	80	83	83	-	-

The expanded uncertainties given in this table are expressed in µH/H

Electricity and Magnetism, United Kingdom, NPL (National Physical Laboratory)**Uncertainty table: Matrix 9**

AC voltage ratio: real component, NPL Internal Identifier: 184

AC voltage ratio: real component, NPL Internal Identifier: 190

AC voltage ratio: real component, NPL Internal Identifier: 202

	20 Hz	30 Hz	40 Hz	60 Hz	80 Hz	103 Hz	120 Hz	203 Hz, 303 Hz, 400 Hz, 600 Hz, 800 Hz, 1000 Hz, 1300 Hz, 1592 Hz	2 kHz	3 kHz	4 kHz	5 kHz	8 kHz	10 kHz
4 V	2.00E-07	-	1.60E-07	-	-	-	-	-	-	-	-	-	-	-
6 V	-	2.00E-07	-	1.60E-07	-	-	-	-	-	-	-	-	-	-
8 V	-	-	1.80E-07	-	1.20E-07	-	-	-	-	-	-	-	-	-
12 V	-	-	-	1.70E-07	-	-	-	-	-	-	-	-	-	-
16 V	-	-	-	-	1.30E-07	9.10E-08	-	-	-	-	-	-	-	-
18 V	-	-	-	-	-	-	7.00E-08	-	-	-	-	-	-	-
30 V	-	-	-	-	-	-	-	6.10E-08	6.80E-08	9.00E-08	1.40E-07	2.10E-07	-	-
60 V	-	-	-	-	-	-	-	-	-	-	-	2.10E-07	2.90E-07	3.80E-07

	20 kHz	30 kHz	40 kHz	50 kHz	80 kHz	100 kHz	120 kHz
4 V	-	-	-	-	-	-	-
6 V	-	-	-	-	-	-	-
8 V	-	-	-	-	-	-	-
12 V	-	-	-	-	-	-	-
16 V	-	-	-	-	-	-	-
18 V	-	-	-	-	-	-	-
30 V	-	-	-	-	-	-	-
60 V	7.10E-07	1.20E-06	1.80E-06	2.80E-06	6.20E-06	9.80E-06	1.50E-05

The expanded uncertainties given in this table are dimensionless

Electricity and Magnetism, United Kingdom, NPL (National Physical Laboratory)**Uncertainty table: Matrix 10**

AC voltage ratio: imaginary component, NPL Internal Identifier: 213

AC voltage ratio: imaginary component, NPL Internal Identifier: 219

AC voltage ratio: imaginary component, NPL Internal Identifier: 231

	20 Hz	30 Hz	40 Hz	60 Hz	80 Hz	103 Hz	120 Hz	203 Hz	303 Hz, 400 Hz, 600 Hz, 800 Hz, 1000 Hz, 1300 Hz, 1592 Hz	2 kHz	3 kHz	4 kHz	5 kHz	8 kHz
4 V	2.00E-07	-	1.70E-07	-	-	-	-	-	-	-	-	-	-	-
6 V	-	2.00E-07	-	1.70E-07	-	-	-	-	-	-	-	-	-	-
8 V	-	-	1.90E-07	-	1.40E-07	-	-	-	-	-	-	-	-	-
12 V	-	-	-	1.80E-07	-	-	-	-	-	-	-	-	-	-
16 V	-	-	-	-	1.50E-07	1.10E-07	-	-	-	-	-	-	-	-
18 V	-	-	-	-	-	-	8.30E-08	-	-	-	-	-	-	-
30 V	-	-	-	-	-	-	-	7.60E-08	-	2.10E-07	7.90E-08	9.70E-08	1.40E-07	2.10E-07
60 V	-	-	-	-	-	-	-	-	-	-	-	-	2.10E-07	2.90E-07

	10 kHz	20 kHz	30 kHz	40 kHz	50 kHz	80 kHz	100 kHz	120 kHz
4 V	-	-	-	-	-	-	-	-
6 V	-	-	-	-	-	-	-	-
8 V	-	-	-	-	-	-	-	-
12 V	-	-	-	-	-	-	-	-
16 V	-	-	-	-	-	-	-	-
18 V	-	-	-	-	-	-	-	-
30 V	-	-	-	-	-	-	-	-
60 V	3.80E-07	7.40E-07	1.20E-06	1.90E-06	2.90E-06	6.40E-06	1.00E-05	1.60E-05

The expanded uncertainties given in this table are dimensionless